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Editorial:

"In the National Park System I advocate a policy based on three words: 'Let it be' (as God made it). When there has to be interference, it should never affect the natural resource."

These words from Frank E. Masland, Jr., long-time friend and benefactor of the National Park Service and System, were sent along to *Park Science* by NPS Director William Mott. Mott's "cherished friend," Frank Masland, delivered his remarks before a group of fellow Rotarians recently at Carlisle, Pa., and Director Mott responded with appreciation for the fact that "at age 92, you still have the conservation ethic burning bright within you."

The words "let it be" are "precious ones to keep in mind," Mott wrote to Masland. "With thoughts and help from dear friends such as you, I am confident that a legacy we can be proud of will be handed down to be enjoyed by future generations."

Excerpts from Masland's speech follow:

"At 92, all my thoughts are for the future.

"Preserve, protect, progress – the paradox seemingly contradictory – calling for the exercise of great wisdom, utterly unselfish wisdom. All is to be used. God gave man dominion. With it He also gave man responsibility. All is to be used *wisely, unselfishly*. For 50 years I have been involved in preserving and protecting our land. Why? It was my attempt to pay my debt to those who came before and to my God for the privilege of living in freedom and in beauty.

"Youth must have the opportunity to walk in wilderness . . . to lift their eyes to the hills . . . to marvel at the dance of leaf-filtered sunlight on clear pure streams . . . to worship in the cathedral of tall trees whose roots are buried in the mystery of a swamp.

"Ask yourself if you would want to live when no farm land remains in the valley, when it is built solidly with row houses . . . heavy industry belching pollution, trucks everywhere, our good land under concrete slabs. The time to decide is now, for this nightmare doesn't happen overnight but rather day by day, inch by inch.

"It is a challenge for one and all, for *we will be what we will*."

And how does Masland define the challenge? This way:

"It is a challenge to preserve what is good and to add only what enhances what we preserve."

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Cover: Shoreline beaches at Glen Canyon National Recreation Area. (Story on pages 3 and 4).

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Study Provides Dynamic Picture of Lake Powell's Boater Use Capacity

By Charles W. Wood and Mike Snyder

Glen Canyon National Recreation Area (NRA) is a developing unit of the National Park System in Utah and Arizona whose major recreational resource is Lake Powell. Five permanent developed marinas, plus a temporary marina on the San Juan arm, operate on its 1900-mile shoreline. Plans for two new marinas and expansion of several existing facilities recently were approved.

Because it is difficult to gauge the cumulative effect of these new developments and expansions, an assessment of the lake's capacity to absorb increased boater use was undertaken to determine development sizes consistent with preservation of park resources and recreation quality.

A study by the Denver Service Center (DSC) in 1982 had identified physical and operational factors affecting boat distribution and boater carrying capacity and had produced models illustrating how boater carrying capacity might be arrived at under varying scenarios. In 1985, Supt. John O. Lancaster decided to quantify boater use limits through a park field study, and to include resource and recreational quality factors. This study, recently completed, appears in a document titled *The Carrying Capacity of Lake Powell, A Management Analysis of Capacity for Boater Use*, (76 pp., available from Glen Canyon NRA, P.O. Box 1507, Page, AZ 86040).

Potentially limiting factors were chosen for evaluation based on information from the 1982 DSC work, park resource monitoring data, and the need to incorporate recreational quality. The factors selected were physical capacity, water quality, shoreline impact, safety, and a three-level spectrum of potential recreational experiences based on density of boaters staying overnight onshore. These levels were termed "semi-primitive," "rural/natural," and "urban/natural."

Data-gathering began with a survey of boaters at the park in 1985 to update information on boater recreational activities, boater distribution on the lake, and length of stay and size of groups. Prior to survey and

monitoring, the lake was divided into 13 geographic zones. Nearly 300 boater groups were interviewed after their trips and asked to complete a trip diary. Questions related to their activities and the impact factors that affected their trip.

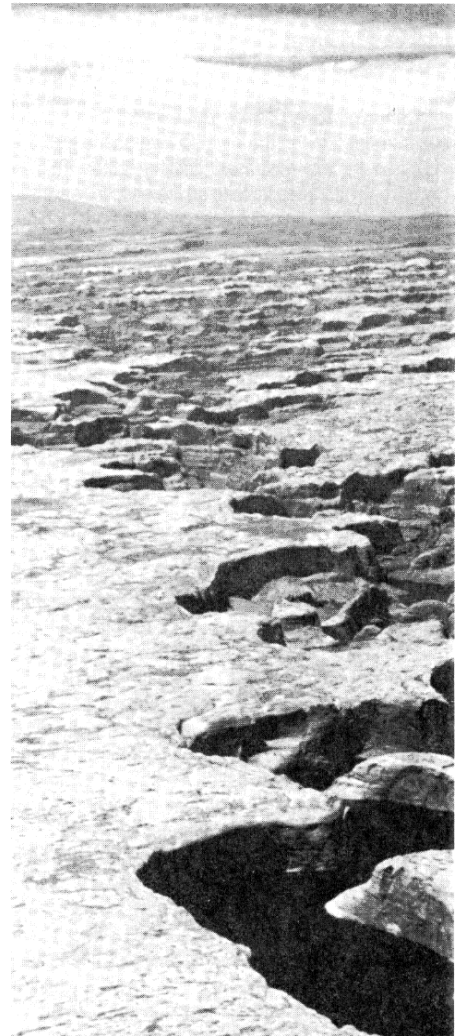
Results were coded into a Lotus 1-2-3 spreadsheet for analysis, yielding a table of boater distribution for each of the zones by marina of origin. Field monitoring of lake resource impacts resulting from boater use was completed in 1985 and 1986, concentrating on shoreline water quality and shoreline campsite impact (trash, human waste, fire rings.)

To arrive at capacity estimates, maximum "limits" for each factor were set, based on documented criteria and beyond which the visitor experience and/or resource could be presumed to deteriorate. For example, the limit for physical capacity was the number of adequate shoreline campsites in each zone. These were counted. For water quality, the limit set was the health standard for bacterial content of water used for swimming. For shoreline impact, the limit was based on the amount of trash and human waste around campsites beyond which an increase was noted in complaints from the visitors surveyed.

User density limits corresponding to the recreational opportunity types were derived from the size of each zone in relation to the length of its shoreline (giving a measure of the opportunity for isolation), and user density factors for differing experiences obtained from the literature (Moe and Underhill; USDA Forest Service). These results were translated into the desirable size and development facilities for launching boats – the management control – using a two-step process.

Step I. A limiting factor matrix was prepared using the distribution of boaters to each zone found in the survey. Knowing the number of boats launched during impact studies (from visitor use statistics) it was possible to calculate how many boats it would take to cause each factor to reach its limit in every zone. A matrix of this information is shown in Table 1.

Step II. Identification of the boat launch rates from marinas that would result in a distribution of boaters



Escalante Arm, Lake Powell NRA, has low physical capacity and is deemed a "semi-private" recreational opportunity.

matching the lake's carrying capacity was next. After identifying the "most limiting" factor in each zone, by reference in Table 1 (expressed as boats-at-one-time in the zone), and using the distribution factors from marinas with lengths-of-stay observed during the visitor survey, it was possible to estimate the daily launch rate at each marina that would produce a distribution of boats on the lake equaling the carrying capacity of each zone as gauged by the most limiting factor in each of the zones. This procedure is illustrated in Table 2. (Note: the ROS category used was determined by management objectives for each area as stated in planning documents. It is not only the lowest-density category.)

Table 2 yields a boat launching rate for each of the marina areas that matches carrying capacity. This information affords park management a development planning tool for judging the maximum boat launching capability for each marina consistent with park objectives. Planners are thus able to allocate the number of boat launches among the various facilities – public launch ramps, rental boats, and private slips or moorings.

The study also provides management with the conditions under which the lake's boater use capacity may be increased: Mitigation of the most limiting factor at



Memorial Day recreationists crowd Lone Rock beach, an "urban/natural" recreation opportunity area.

Continued on page 4

Lake Powell Study

Continued from page 3

a given lake zone permits the number of allowable boats-at-one-time in the zone to increase to the level indicated by the next-most limiting factor. This increase can be traced back to an increase in maximum allowable marina launch rates using methods outlined in the study. In this way, guidance may be obtained on which alternative management actions would be most useful for mitigating capacity constraints and where on the lake they could be most effectively applied.

As an illustrative exercise one can ask, for example, what effect mitigation of water quality and shoreline impact lakewide would have on the limits to boater use. When water and shoreline impacts were not considered as limiting factors and a new table of marina launch rates calculated, it was found that instituting programs to maintain water quality and clean shorelines would double the lake's effective carrying capacity.

The same exercise can be repeated, assuming mitigation only in specific zones, to document where on the lake mitigation would most efficiently alleviate constraints on additional use. This type of analysis is useful in situations where mitigation is a feasible course of action and excess user demand exists. (If the limits to capacity are physical or safety constraints, mitigation usually would not be feasible. The management action would be to keep development to a level consistent with those constraints.)

At Glenn Canyon, the capacity estimates have been directly useful in evaluating planned marina expansion. In Table 3, the results from Table 2 are expressed as "carrying capacity launch rates," and are compared with "existing and approved marina launch capacities." (Marina launch capacities are the physical ability of marinas to launch boats based on the number of lanes at the ramp, number of mooring buoys and slips, etc.) The comparison of projected expansion of marina launch capacities with known carrying capacity led to adoption of a recommendation that marina expansions be accompanied by programs to maintain water quality and clean shorelines.

Although many carrying capacity studies have been done for land and river recreation, few flatwater area studies consider the physical, resource, and recreational limits important to park management. Fewer still offer a means of quantifying capacity. The method used in the present analysis is a way of organizing information to document a management problem, and could be applied to other areas of the National Park System concerned with carrying capacity. The principal requirements are a system for examining the distribution of use, and sufficient resource monitoring data to correlate user impacts with use intensity.

Wood is a Biologist at Glen Canyon NRA; Snyder is a Landscape Architect with the Rocky Mountain NP Region Office.

REFERENCES CITED

- Moe, T.M. and A.H. Underhill, 1982. *A Manual to Determine Recreational Carrying Capacity. Park Studies Unit at University of Arizona. Special Report No. 1. Tucson, AZ.*
- U.S. Department of Agriculture. Forest Service. *User Guide to the Recreational Opportunity Spectrum. Updated. (Internal guide for forest planning. No further publication information available at presstime.)*

Table 1. Limiting Factor Matrix (Number of Boats-At-One-Time)

Zone	Physical	Safety	Water Quality	Shore Impacts	Recreational Opportunity Spectrum (ROS)		
					Semi-Primitive	Rural/Natural	Urban/Natural
1	1088	1054	467	NL	N/A	527	1054
2	951	903	233	444	N/A	903	903
3	2090	1415	NL	1950	102	809	N/A
4	1431	2094	621	NL	151	1047	N/A
5	1770	2950	ND	830	385	2212	N/A
6	729	1529	1722	262	1147	1529	N/A
7	751	1236	ND	560	927	1236	N/A
8	1443	1002	ND	250	725	1002	N/A
9	1341	885	253	736	664	N/A	N/A
10	714	1355	2015	232	1016	1355	N/A
11	1588	1997	1217	NL	N/A	998	1997
12	327	1085	183	585	814	1085	N/A
13	2149	2270	95	689	1702	2270	N/A

N/A = Not Applicable; ND = No Data; NL = Not Limited.

Table 2. Carrying Capacity Launch Rates – Existing Management Scenario

BAOT (Boats-At-One-Time)

Dist % (Distribution %, see Table 10)

LOS (Length-Of-Stay, see Table 9)

CCLR (Carrying Capacity Launch Rate)

Zone	Limiting Factor BAOT	Wahweap/Lone Rock/Antelope Pt.			Bullfrog Basin/Halls Crossing			Hite		
		Dist %	LOS	CCLR	Dist %	LOS	CCLR	Dist %	LOS	CCLR
1	467	97	4.3	105.3	3	4.3	3.3	0	4.3	0
2	233	100	3.8	61.3	0	3.8	0	0	3.8	0
3	809	97	4.6	170.6	3	4.6	5.3	0	4.6	0
4	621	94	4.7	124.2	6	4.7	7.9	0	4.7	0
5	830	91	5.6	134.9	9	5.6	13.3	0	5.6	0
6	262	45	5.5	21.4	55	5.5	26.2	0	5.5	0
7	560	26	5.9	24.7	74	5.9	70.2	0	5.9	0
8	250	60	7.0	21.4	40	7.0	14.3	0	7.0	0
9	253	15	5.6	6.8	83	5.6	37.5	2	5.6	0.9
10	252	4	5.1	2.0	85	5.1	42.0	11	5.1	5.4
11	998	5	4.5	11.1	88	4.5	195.2	7	4.5	15.5
12	183	3	5.1	1.1	62	5.1	22.2	35	5.1	12.6
13	95	0	5.0	0	16	5.0	3.0	84	5.0	16.0
		total CCLR 684.8			total CCLR 440.4			total CCLR 50.4		

total lakewide CCLR 1,175 boats/day

Table 3. Comparison of Marina Launch Capacity with Carrying Capacity Launch Rate (launches/day)

marina	marina launch capacity		carrying capacity launch rate	
	existing	approved*	existing	additional mgmt.**
Wahweap/Lone Rock	644	870	↕	↕
Antelope Point	0	240	↕	↕
Bullfrog Basin	220	420	↕	↕
Halls Crossing	145	206	↕	↕
Hite	114	*(114)	50	414
total	1,123	1,850	1,175	2,572

*Launch rates from proposed facilities in current plans.

**Additional management – applying management actions to a particular limiting factor to increase BAOT capacity.

Dendrochronology in National Parks: A Mammoth Cave Case Study

By Paul R. Sheppard, Edward R. Cook, and Gordon C. Jacoby

The science called dendrochronology – the study of the past using tree rings – depends on old trees for data. Variation in annual tree-rings represents information about the past that is otherwise difficult to obtain. Rising concern about global environmental changes makes tree-ring information even more valuable. In view of tendencies to cut large, old trees and in view of the significant information they contain, we support the designation of natural areas (such as in National Parks) that specifically mandate the preservation of old-growth forests.

Dendrochronologists are interested in the patterns of relatively wide and narrow rings (or other varying ring features), which result mostly from the influence of yearly climatic variation. Analysis begins with the crossdating of tree rings, wherein the goal is to assign an exact year date to every ring of every tree sampled within a site. By matching patterns across several trees, we can account for growth anomalies (missing or false rings). Each series is then measured to the nearest 0.01 mm. The ring-width series, which exhibit both standwide and individual variation, are detrended into relative index series by any of various standardization techniques. All index series thus have a stationary mean and variance and are finally merged into a single mean-value index chronology.

For dendroclimatology, the indices are then correlated with meteorological data – a process called climate modelling – which discovers what monthly climate indicators (total precipitation and average temperature) account for the most tree-ring variation. Once a model is developed and verified, it is extrapolated back through the entire length of the tree-ring data, which may span several hundred years. This provides information about long-term variations that aids our understanding of general climate trends.

An important dendrochronological tree species in North America is white oak (*Quercus alba*). Though growing in mesic, closed-canopy stands, oak still displays yearly tree-ring variation (enabling crossdating), and correlation of that variation to meteorological data is sufficiently high for successful climate modelling. Because of its large range, oak provides the added attraction of climate modelling by region as well as through time. Wisconsin's oak probably responds to its climate differently than does Georgia's oak; spatially differing climate responses offer insights into how and when oak expanded to its large range throughout the Holocene.

Among the many oak chronologies constructed at the Tree-Ring Laboratory of Lamont-Doherty Geological Observatory is one from Mammoth Cave National Park, Kentucky. While this park's main resource is underground, it also has a substantial old-growth forest resource. After coring trees, crossdating cores, measuring rings, and constructing the standardized chronology (Fig. 1, top), we correlated the indices to Bowling Green, KY, meteorological data from 1889 to 1985. This analysis used a 17-month "dendroclimatic year," including the previous May through December and the current January through September. This incorporated the biological persistence phenomenon in trees, whereby one year's ring width is determined partly from the previous year's climate in addition to that of the current year. A result of this particular analysis is that Mammoth Cave oak grows best with

a strong June rainfall and a cool summer (June through August) (Fig. 2). In such years, early season water availability is high and seasonal evapotranspiration is low.

Continuing the climate modelling, the Mammoth Cave chronology was merged with six other oak chronologies from the central states. Meteorological data from pertinent locations were also merged and then converted into a single series of Palmer Drought Severity Index (PDSI), which integrates recent past climatic trends plus soil characteristics into values of moisture deficiency or excess (Palmer, W.C., "Meteorological Drought," U.S. Dept. Commerce Res. Pap. 45 [1965]). After constructing, calibrating, and verifying the relationship of tree-ring indices to PDSI, a long series was reconstructed for the region (Fig. 1, bottom); periodicity of severe droughts can be estimated from this reconstruction.

Another interesting species is northern white-cedar (*Thuja occidentalis*). Unlike oak, little of the white-cedar range has been sampled; nonetheless, this lab's only white-cedar chronology, from Gaspé Peninsula, Canada, shows a peculiar "ramp" of increasing growth for the last 140 years (Fig. 3). Short-term departures from the mean of 1 and from a homogeneous variance, such as from about 1850 to present, warrant special attention. Does that "ramp" of increasing indices indicate climate change lasting 140 years? Or is it that something non-climatic is affecting white-cedar growth in Gaspé Peninsula? Hypotheses exist about possible causes of such a trend, but since only one white-cedar chronology exists, other basic questions remain. Do stands of white-cedar from other areas show similar growth increases? Are their climate response models similar? Also, do other species in Gaspé Peninsula show similar trends? Because we have no other white-cedar chronologies (we are currently analyzing cores from two other sites), these basic questions cannot be answered yet.

In addition to climatology, tree-ring analysis has many other scientific applications. Biological (fire or insect) and physical (earthquake or volcano) distur-

bance histories have been developed from tree rings. Even trace metal chronologies have been developed from tree-ring analysis to study air quality trends. Furthermore, many ancient structures of the southwestern archaeological parks have been precisely dated using dendrochronology.

Managers of some natural areas deny permission to sample old trees because of concern about the effects of coring. Such concern is valid, and we attempt to demonstrate that the effects of coring on tree vigor are negligible. First, Alex Shigo ("Wounded Forests, Starving Trees," *Journal of Forestry* 83(11):668-73 [1985]) showed that trees defend themselves by compartmentalizing, or isolating, a wound, thereby preventing pathogens from attacking healthy tissue. As long as a tree is not girdled (we usually extract just two cores per tree), the tree loses only a small proportion of its storage and translocation tissue around the wound. Long-lived species appear to compartmentalize better than others, and while there is some dendroecological interest in short-lived species, we depend mostly on long-lived species.

Second, by returning to sites cored in the past, we are collecting evidence about the effects of coring. For example, we recently re-cored a site of eastern hemlock (*Tsuga canadensis*) for the purpose of updating a chronology constructed in 1974. During the re-coring, the original core holes were indistinguishable because they had filled in with sap and healed over with callus tissue and bark. The only trees with rot were two that originally showed it in 1974. Furthermore, ring-width patterns showed no departures from pre-1974 growth rates that might indicate decline as a result of coring.

Third, old trees have proven their vigor by surviving for hundreds of years. Throughout their lives they have probably been mechanically injured by such disturbances as wind, landslide, avalanche, lightning, fire, scraping from other trees, or even self-pruning. Cut stumps of old trees often display many such wounds that apparently did not affect their longevity. Compared to this disturbance history, a 5-mm diameter core hole is probably negligible.

Nonetheless, we still consider the concern about coring to be valid, so we often consult with natural areas managers about which trees may be sampled and which to avoid, about reducing impact on other

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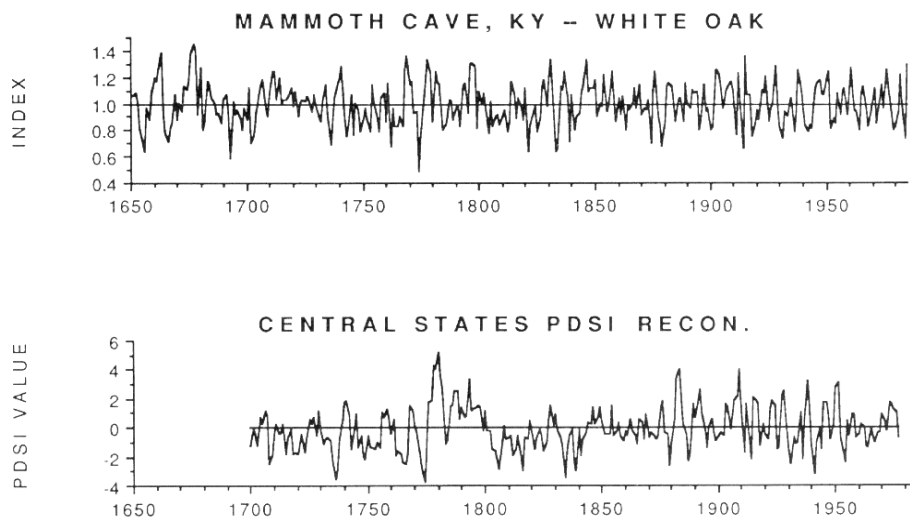


Figure 1. (top) Mammoth Cave NP, KY, white oak tree-ring chronology. (bottom) Central states PDSI reconstruction, based on seven white oak chronologies, including Mammoth Cave.

Relocation Preferred Option to Save Hatteras Lighthouse

By Jim Wood

After a nine month study requested by the National Park Service, an expert committee of the National Research Council has determined that moving the Cape Hatteras Lighthouse about 500 feet southwest of its present location is the best way to save the historic structure.

Relocating the lighthouse away from the shoreline, where erosion threatens to topple the landmark, was deemed to be cheaper in the long run and less likely to damage the century-old beacon than other alternatives, such as building a seawall and revetment around its base or constructing offshore breakwaters and groins in an attempt to halt the erosion.

The 200-foot-tall lighthouse has been standing watch over North Carolina's Outer Banks since 1870, warning ships to steer clear of the treacherous Diamond Shoals – the so-called "Graveyard of the Atlantic," where at least 600 ships have been lost.

Over the years, storms and powerful ocean currents have gradually eroded the eastern shoreline of Hatteras, transporting beach sand to its southern shores in a natural process that's causing the Atlantic barrier islands to migrate westward. At the time of its construction, the lighthouse was approximately a quarter of a mile from the water's edge. Today this cushion has been reduced to a scant 50 yards, and experts say it's only a matter of time before waves undermine the structure and topple it into the sea. A hurricane could wipe it out at any time.

The NPS had asked the Research Council committee in July 1987 to evaluate alternative ways to save the structure. The committee was not asked whether the lighthouse should be saved, but was asked only to determine the best options for preserving it. The Council, an operating arm of the National Academies of Science and Engineering, estimated moving the lighthouse would cost about \$4.6 million and take nearly a year, including planning and site preparation. The actual move will take about three months.

The 2,800-ton tower could be moved safely with proper bracing and engineering techniques, according to the committee. First, the external structure would be strengthened and reinforced as an integral unit by vertical and circumferential prestressing, using concrete tie beams with prestressed rods and tendons. Next, the foundation of the lighthouse would be tun-

neled for insertion of a series of needle beams. The lighthouse (minus part of its below-surface foundation and the timber mat) would then be vertically raised by hydraulic jacks to clear the below-surface foundation that remained.

The lighthouse would be lowered onto rollers that rest on multiple horizontal steel-rail beams supported by precast concrete piles. The entire lighthouse structure would be moved on the tracks with hydraulic jacks and slowly pulled with winches to its new site, where it would be placed on a newly-constructed foundation, such as a pile-supported concrete mat. The Keeper's Quarters and other buildings in the complex would also be moved (using standard housemoving techniques) and placed in the same proximity to the lighthouse.

Because the lighthouse may have to be moved again in 25 to 100 years to escape additional beach-front erosion, the committee proposed that the lifting beams be left in place to facilitate future relocation. Such "multi-stage" relocation would be a "flexible response to a dynamic problem," the committee said. With this foundation in place, a second move would cost about \$1.6 million in 1988 dollars, the committee projected.

Building a seawall would cost at least \$5.6 million by Army Corps of Engineers estimates. During the year-long construction process, the lighthouse would be particularly vulnerable to risk from storms. The seawall option also conflicts with many national, state, and NPS policies. Moreover, the wall would obscure much of the lighthouse itself, while continued erosion would eventually separate the lighthouse from the mainland and effectively foreclose future preservation options, the report says.

Rebuilding the existing groinfields and providing a protective underground casing or revetment to prevent undermining of the lighthouse would take less than a year and cost from \$4.7 to \$6.7 million. While it would protect the lighthouse for 20-30 years (barring a disastrous storm), the committee said, it would be difficult, if not impossible, to maintain a protective beach in front of the lighthouse indefinitely. The revetment casing would make future relocation difficult and expensive and also conflicts with relevant public policies, it noted.

The committee considered other options, as well, but rejected them after preliminary study showed them to be even more unsuitable than the seawall or groin-field options.

Because of the intense public interest in preserving the lighthouse, a new Park Service document evaluating these options is scheduled to be released for public comment this fall. The alternatives will be (1) moving the lighthouse to one of several possible sites, (2) building the seawall and revetment, or (3) a combination of a smaller revetment and improvements to the existing groins.

(Wood is a Technical Publications Writer/Editor with the NPS Southeast Regional Office, Atlanta, Georgia.)

Dendrochronology

Continued from page 5

projects, and about eliminating impacts on visitor use and esthetic quality. We also report about the dendrochronology of specific sites to area managers; in addition, we provide base-line data, and our reports have been the bases for occasional interpretive features on the history of the trees.

Such interpretation could help visitors realize the scientific value in addition to the esthetic appeal of old trees. Most National Parks are noted for scenic

grandeur and wildlife values; the preservation of old growth forests is an important mandate in many of these same parks. Because of these natural areas of old-growth forests, we have often looked to the National Park System for tree-ring sampling sites; our Mammoth Cave case study encourages us to continue that relationship.

The authors are scientists at the Tree-Ring Lab, Lamont-Doherty Geological Observatory, Palisades, NY 10964.

CORRELATION ANALYSIS

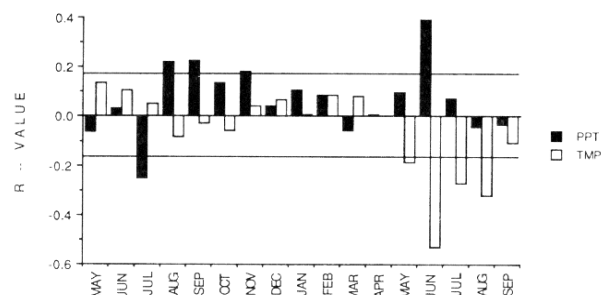


Figure 2. Correlation analysis of Mammoth Cave white oak tree-ring indices and monthly climate variables (dark bars show total precipitation and light bars show average temperature from Bowling Green, KY. All correlations beyond the reference lines are significant to the 0.10 level.

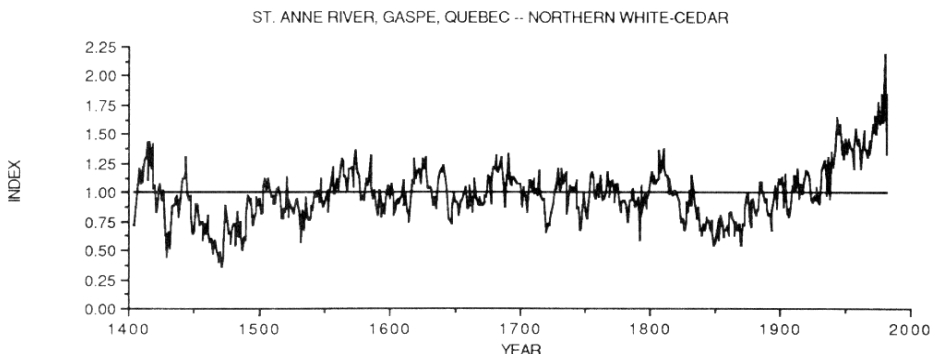


Figure 3. Northern white-cedar tree-ring chronology from Gaspé Peninsula, Canada. Notice the trend of increasing growth since 1850.



The Cape Hatteras Lighthouse is the tallest brick lighthouse in the United States. Weighing 2,800 tons, it is also one of the heaviest.

Aquatic Ecology at Great Smokies

A survey is underway at Great Smoky Mountains NP (GRSM) of the population genetics of brook trout, the only native salmonid species in the Southeast. For years, New England strain brook trout were stocked in GRSM streams to replace native brook trout populations that had been severely reduced or eliminated as a result of past human activity. It has been suggested by several authorities that the native fish is different from the hatchery strain. This question is being explored by a study begun in 1987, designed to determine if brook trout from park streams that were never stocked differ in any consistent way from brook trout from streams that were stocked with New England strain. Starch gel electrophoresis is being used to examine the genetic makeup of the different populations. Preliminary results indicate differences among populations for several enzyme systems, but no conclusions can yet be made regarding differences between studied and unstocked populations. The study is continuing.

A survey of park springs was begun in 1988. This preliminary effort is designed to gather basic physical and biological information on these fragile habitats in order to develop a classification scheme that can be used in implementing an inventory and monitoring program for park springs.

The entire stream network of GRSM has been digitized and proofed on the park's geographical information system (GIS). This gives us the capability to analyze stream characteristics in relation to all other digital cartographic data bases for the park, such as fish species distributions, elevation, slope, vegetation, fire history, and roads.

New Educational Resources at National Colonial Farm

By Donald W. Strasburg

The Accokeek Foundation's National Colonial Farm (NCF) is part of the Piscataway NP, located on the Maryland banks of the Potomac River opposite Mount Vernon. A living historical farm, NCF depicts life on a one-family tobacco plantation in 1750. About half of the NCF visitors are school groups, many from the inner cities of metropolitan Washington, D.C. and Baltimore. Surprisingly few of these young people have had any prior exposure to rural life or to the natural history that abounds in farm gardens, fields and forests. Thus, besides learning about their colonial heritage, many young visitors acquire knowledge of things the rest of us take for granted. A typical question put to a docent might be "Is that where milk comes from?", meaning a cow!

Recognizing an opportunity to broaden its educational function, NCF has recently added to its offerings three new educational resources: an herbarium, a reference collection of insects, and an arboretum. Because of their fragility or technical nature, not everything in these collections can be shown to all visitors, but plans are underway to increase visitor exposure via the docents who conduct the tours and by means of special displays. Although the plants and insects are contemporary, most were also present in 1750, and their beneficial or harmful effects were as pertinent to the 18th Century tobacco farmer as they are today.

The herbarium is the result of a botanical survey of NCF's vascular plants completed by Dr. Steven R. Hill (now of Clemson University) in 1984. The survey included all clubmosses, ferns, conifers and flowering plants, but excluded algae, fungi, lichens and mosses. A pressed specimen of each species found in the survey has been mounted on the highest quality herbarium paper, labeled, placed in a protective folder, and stored systematically in a fumigated cabinet. Within each of the four major plant categories, the plant families, genera, species and varieties are arranged alphabetically. Each herbarium sheet bears a reference number that ties it to an index kept in the herbarium cabinet. Index entries consist of the full scientific name, author citation, common name or names, and text, telling whether the plant is a native or introduced and from where, flowering time, frequency of occurrence at NCF, locations at NCF, Dr. Hill's collection or reference number and comments such as general occurrence in Maryland, edible or poisonous properties, and whether the species should be carefully preserved.

At the back of the index are a summary, alphabetical index, maps and suggested references. The collection contains 441 species, 304 genera and 100 plant families. Of this number, 328 are native species and 113 introduced, mostly from Europe.

The herbarium was assembled in the best botanical manner, and contains specimens and data of interest to a professional botanist. After making prior arrangements with NCF, such visitors can have free access to the herbarium.

The NCF insect collection was begun in 1985 by Donald W. Strasburg, a volunteer entomologist at NCF, and is expected to be completed in 1988. Because of the vast numbers of insect species, completeness was never an aim; instead the collection contains most of the larger species likely to be en-

countered, a representative sampling of the smaller species, and some numbers of those species that are beneficial or deleterious agriculturally.

The collection consists of twelve 14" x 21" Riker Mounts (here the insects are bedded on resilient synthetic fiber, without pins) and eighteen 14" x 21" display cases where they are simply mounted on pins. The sealed Riker Mounts are relatively shockproof, and hence can be passed around or displayed where some handling is permitted. They contain the larger butterflies and moths exclusively. These showy insects invariably attract attention and young people deserve the opportunity to examine them closely.

The smaller butterflies and moths and all other insects are pinned in display cases, shown on tabletops, where visitors merely view them and read the textual material. All specimens are labeled with full Latin name, common name, citation and a description of life history and habits. This is done on a species basis for the large forms and by family or order for the small species belonging to the lesser orders. With the Hymenoptera (bees, wasps, and ants) and Diptera (flies and mosquitos) as yet undone, the collection presently contains representatives of 20 orders, 94 families, 296 genera and 391 species, subspecies and forms. Where the sexes are different, both are shown, and in some cases the underside as well. Additional display cases and Riker Mounts probably will be added to house freeze-dried larvae and soft-bodied non-insects such as spiders, chrysalids, cocoons, egg masses, and examples of insect destruction of crops, wood, fabrics.

The arboretum was conceived in 1986 by Frederick Tilp as an educational heritage. Saplings of trees native to the NCF area have been purchased each year, with the goal of completing the planting in 1988. The arboretum is located in what had been a gently sloping hillside meadow, adjacent to a native oak-hickory forest. Visitors can stroll through the plantings in natural surroundings, and by facing west have a commanding and beautiful view of NCF, the Potomac River and Mt. Vernon. The arboretum eventually will contain 128 species, 59 genera and 29 families. Labels give the full scientific and common names, and a handout map locates each species. Grass and invasive seedlings are mowed to reduce competition and permit easy access. As the trees reach the flowering and fruiting stages their interest value will increase because of the accompanying influx of bird and insect visitors. NCF visitors are encouraged to visit the arboretum as well as the colonial area of the farm.

For those with an interest in a contemporary forest, an eastern hardwoods nature trail lies adjacent to the arboretum. Many of the arboretum species can be seen there again, with their associated vines, shrubs, weeds, birds, insects and forest-floor communities.

Even though in differing stages of development, these three facilities have drawn local attention. As awareness of their existence spreads, and as the arboretum grows, we anticipate wider use by the public, natural history study groups and researchers. Facilities such as these constitute an important adjunct to any NPS management area, both as natural history baselines and as educational tools.

Dr. Strasburg is a Fellow of the Accokeek Foundation's Research Program.

Manned Submersible Allows First Look at Secret Depths of Deepest U.S. Lake

By Jean Matthews

The somewhat shopworn phrase "wonders of the deep" is taking on glorious new luster at Crater Lake NP where the first manned probe ever to explore the lake depths has just concluded. The action was initiated in response to a Congressional requirement to identify significant thermal features in National Parks and was integrated into a 10-year Congressionally mandated research project (P.L. 97-250) that began in 1983.

What has been found so far in the overall 10-year study is enough to keep scientists busy analyzing, interpreting, and hypothesizing for years to come. The flood of data will be organized into a final report by the Crater Lake team and written by NPS Limnologist Gary Larson, who is based at Oregon State University's NPS/CPSU.

Bob Collier and Jack Dymond of the OSU College of Oceanography faculty, who have taken turns manning deep dives in the mini-submarine Deep Rover, are the principal investigators. They describe their experiences down near the 1,932 foot depths as "exhilarating" and express surprise at the rough terrain with its sharp outcrops and clifflike features.

At the 200 foot level, near Wizard Island, the bottom is covered completely with moss about a foot high that waves in the wash of the submarine. "It's a spectacular scene," says Dymond. "It looks like a grassy field."

Much further down, at around the 1,500 foot level where no light penetrates, large bacterial mats were found. Jim Milestone, NPS Resource Management Specialist at Crater Lake and on-site logistical coordinator of the research operations, calls this find "spectacular stuff." He describes it as looking "like the flowstone you find in caves."

The mats range from 8 x 5 feet to the size of a pie plate and are about 4 inches thick, whitish in color, with orange, iron oxide stainings. The water in these mats was found to be about 6 degrees Celsius warmer than the surrounding water. The mat water was 9.5°C. (49.1°F) compared to surrounding water temperature of 3.5°C (38.3°F). The first scientific surmise is that sulfur oxidization is providing the energy for bacterial growth. Samples of the growth have been sent to Cliff Dahm at the University of New Mexico for analysis. Dahm was formerly on the OSU biology faculty and worked on prior research at the lake.

Dymond also found a manganese (Mn) crust atop floor sediment at about 1,500 feet. The dark gray and black layers of manganese and iron found on the bottom in earlier dives are believed by Dymond and Collier to be dissolved minerals precipitated out and deposited when hot water from deep below the lake hits the cold lake water.

At the lake bottom, from 1,400 to more than 1,700 feet down, the pilots saw buff colored sediment, rocks, cliffs, and previously unknown fault scarps. They also noted avalanche debris and sunken trees that have rolled down from the caldera rim and into the lake.

Dr. Charles Bacon of the U.S. Geological Survey, who had conducted long-standing research of the area's geology, also is taking advantage of the two years of manned submersible studies programmed for Crater Lake in 1988-89. The USGS covered the submersible costs for several days of diving, and Bacon expects the findings to furnish information that

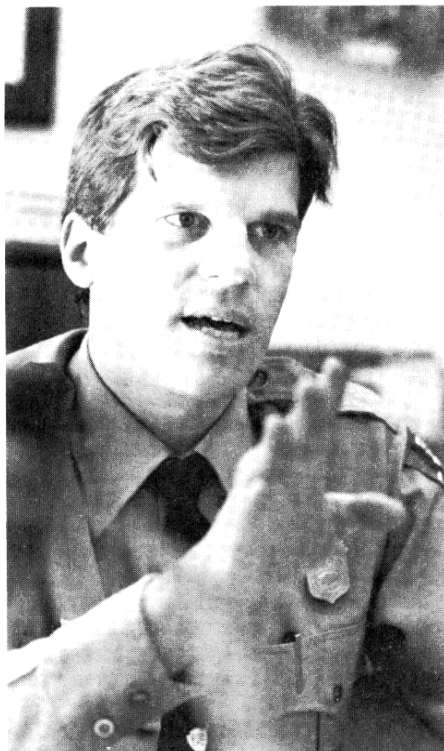
will describe more precisely the volcanic history of Mount Mazama. He hopes the data will indicate where lie the foundations of the original mountain, whose eruption and collapse created the Crater Lake basin.

(The explosion of this 12,000 foot volcano almost 7,000 years ago sent 18 cubic miles of earth and rock hurtling into the atmosphere and changed for years the climate of the world. The volume extruded was more than 50 times the amount produced by Mount St. Helens in its 1980 explosion. The caldera formed by Mount Mazama's collapse gradually filled with rain and snow water, forming the lake.)

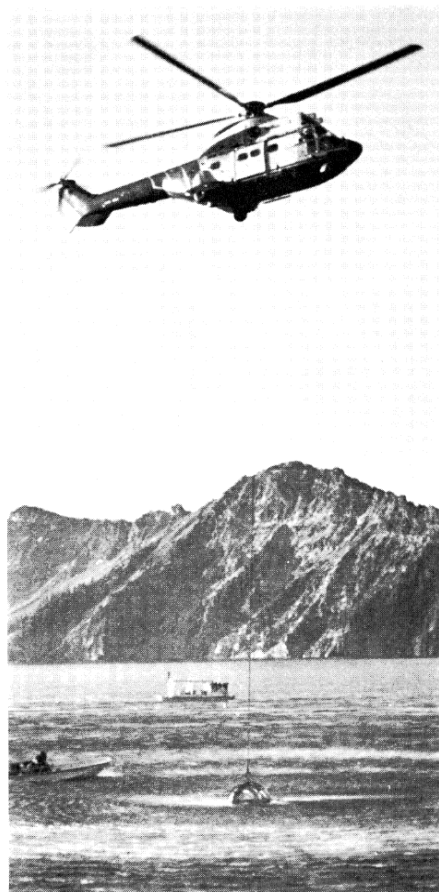
Mark Buktenica, aquatic biologist on the Crater Lake staff, made the deepest dive, concerning himself with biological and geological features, mainly along the lake's south wall down to under the 1,700 foot level.

Milestone's duties as operations coordinator have involved some metaphorical "scarps and crags" to match those found in the lake. For instance: The original plan was to have Deep Ocean Engineering of California supply a submersible called Deep Flight, which would have weighed only 3,300 pounds. Deep Flight, as it turned out, could not be built in time for the 1988 field season. The only available substitute was Deep Rover, from Can-Dive Services in Canada, which weighed in at nearly 2½ times as much — 7,600 pounds. So it was up to Milestone to find a helicopter big enough to lower this comparative behemoth into the lake and haul it out again at the end of three weeks of exploration. A helicopter that would do the trick finally was located in Denver.

Milestone also was in charge of converting the



Jim Milestone, Crater Lake Natural Resource Management specialist, has overall charge of research logistics and operations. (Photo by Dan Clark, *The Bend Bulletin*.)



Steep caldera walls make lake access possible only by helicopter for the 7,600 pound Deep Rover.

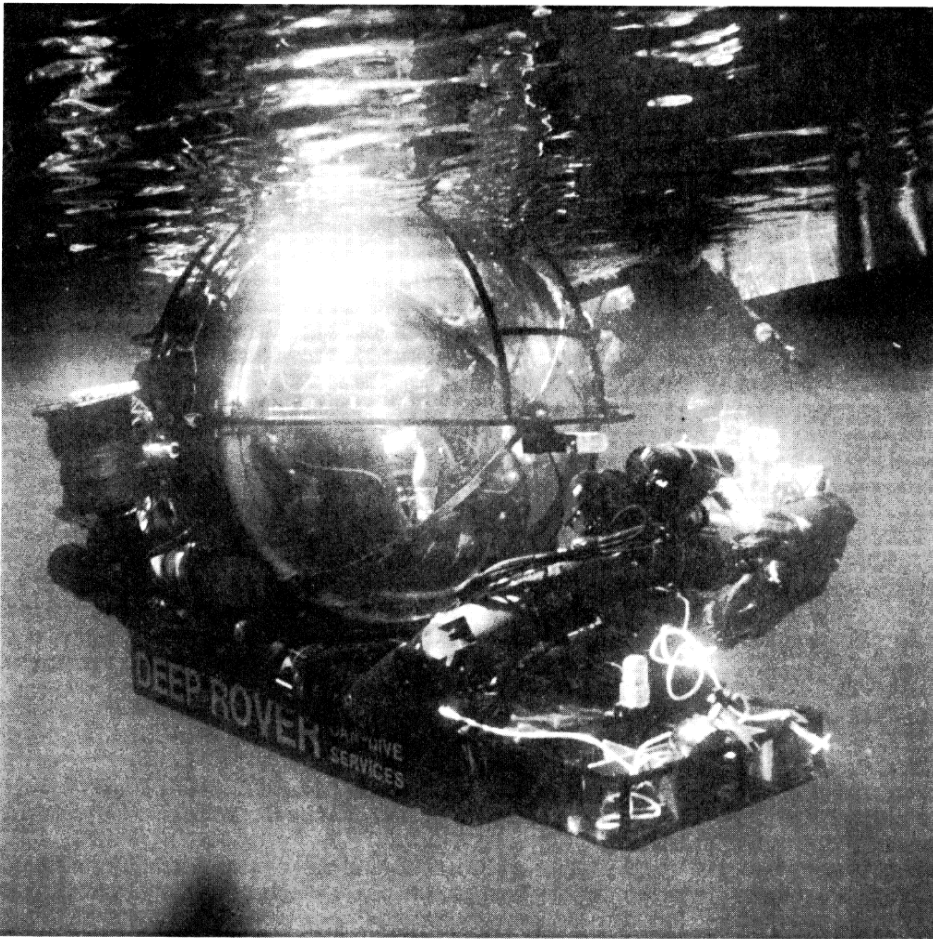
Wizard Island research station, equipped only for emergency use, into a facility that would support 8 people overnight for a month. This included setting up fuel storage docks and board walks over the lava rocks, plus organizing and delivering 10 tons of supplies and materials to support the work on the lake. It also required the scheduling of daily operations around the clock (which sometimes was still running at 2 a.m.)

As the dives developed, it was found that the navigational systems were not working as advertised and as needed. Instead of signaling every 60 seconds, the mechanism was delivering cues only every 5 minutes. The result was inability to document accurately the locations of the surface boat and the sub, which resulted in "a sort of aimless wandering" in efforts to transect the bottom. Eventually, a massive team effort solved half of the problem, but the systems still lacked the ability to establish grid patterns on the lake bottom.

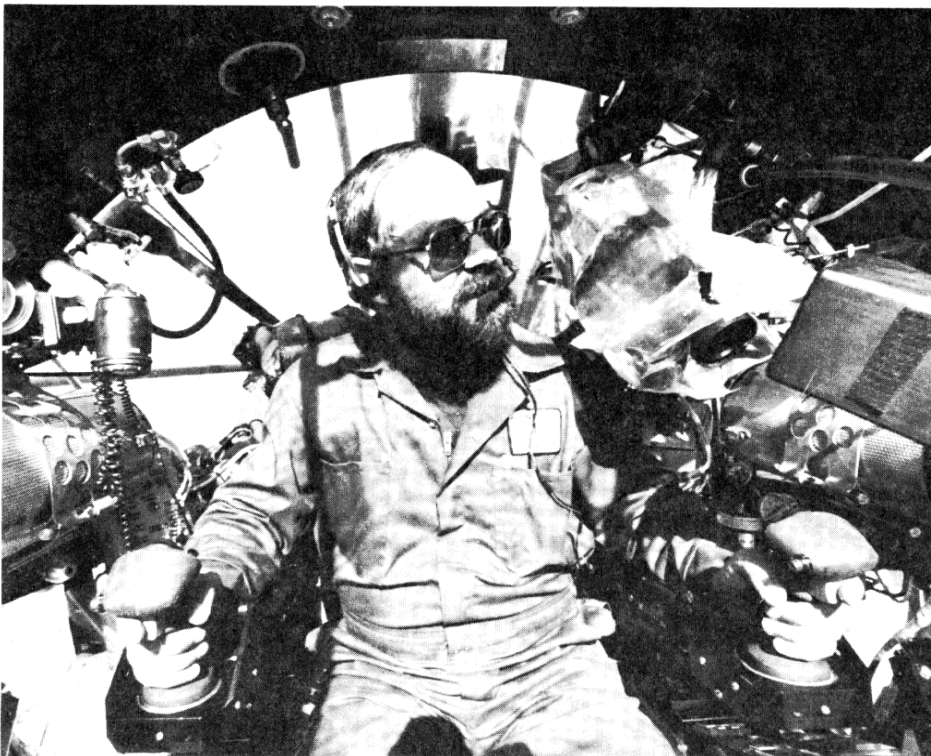
Using Deep Rover's maneuverable arms, fingers, and a suction device, the pilots were able to take rock, moss, bottom fauna, and water samples that will help the investigative team fill in their picture of the lake environment.

Preliminary indications are that perhaps unique communities of diatoms and mosses are interacting at what may be record levels under water and that "designer rocks" have been found that may tell a much more precise story of Crater Lake's dramatic origins. An article describing all these and other interlocking discoveries will be prepared by the research team and their cooperators for an early future issue of **Park Science**, according to Gary Larson.

mab notes



Heading down to the floor, more than a third of a mile below the surface, Deep Rover begins its underwater prowl in search of information about the origins and environment of Crater Lake.



Learning to work the Deep Rover extensions of his arms and fingers, Robert Collier, assistant professor of oceanography at Oregon State University, prepares to take the submersible to the bottom of Crater Lake.

Southern Appalachian Agreement Signed. On August 10 the interagency agreement for establishing and operating a Southern Appalachian Man and the Biosphere Cooperative (SAMAB) was signed at Asheville, NC. The signatories were: National Park Service, Forest Service Southeast Regional Office, Forest Service Southeastern Forest Experiment Station, Fish and Wildlife Service, Tennessee Valley Authority, and Economic Development Administration. The Department of Energy is expected to sign soon. SAMAB's first research project will be a regionwide classification of ecosystems and a geographic information system, in preparation for developing a Southern Appalachian conservation database. NPS is providing partial funding.

FY 1988 Research Grants Awarded. At its June meeting, the U.S. MAB National Committee awarded grants totaling \$437,600 to eight research projects. One of these was: *Ecological Restoration of Degraded Caribbean Dry Forest*. Funded at \$50,000, sited at Virgin Islands National Park and Biosphere Reserve, and directed by Dr. Becky J. Brown, University of Wisconsin, the research will test the ability of degraded dry forests to regenerate spontaneously and will explore ways to accelerate the recovery process.

Other projects were: *Diversity of Tropical Forest Canopy Species and an Integrated Conservation Strategy*, \$76,375, Dr. Ilar Muul, Smithsonian Institution; *Ecology, Use and Management of Minor Forest Products in West Kalimantan, Indonesia*, \$50,000, Dr. Christine Padoch and Dr. Charles Peters, The New York Botanical Garden; *Site-Specific Research and Training in Beni Biosphere Reserve Tropical Forest in Bolivia*, \$49,916, Dr. Francisco Gomez-Dallmeier, Smithsonian Institution; *A Regional Comparison of the Functional Characteristics of Wetland Ecosystems*, \$50,000, Dr. Charles R. Goldman, University of California, Davis, Dr. Robert J. Livingstone, Florida State University, and Dr. Robert J. Naiman, University of Minnesota; *Project to Examine Capacities and Strategies for Coping with Effects of Severe Sustained Drought in Portions of the Southwestern United States*, \$54,500, Prof. Frank Gregg, University of Arizona, and Prof. David H. Getches, University of Colorado; *Modeling Urban Ecosystem Research and Application: A Mexico City Case Study*, \$56,831, Merrill K. Ridd, University of Utah; and *Impacts of High-Intensity Prescribed Fires on Forest Ecosystems in the Southern Appalachian Mountains of Western North Carolina*, \$49,985, Dr. Jack B. Waide, USDA Forest Service.

MAB has also funded feasibility studies for proposed biosphere reserves in southern Florida, southern Arizona, and Acadia-Maine archipelago region.

New Bibliography on Biosphere Reserves. At press time a draft revision of the 1985 bibliography on biosphere reserves was out for review. Titled *Bibliography on the International Network of Biosphere Reserves: MAB Project 8*, it lists publications on the biosphere reserve concept and its application, and on major research or education programs that demonstrate biosphere reserve objectives, anywhere in the world. It does not include publications on specific research projects. Copies may be obtained from: Dr. William P. Gregg, MAB Coordinator, National Park Service (490), Department of the Interior, P.O. Box 37127, Washington, D.C. 20013-7127.

Napier Shelton, NPS Washington Office

The NPS Inventory & Monitoring Initiative

A Hierarchical Strategy

By Raymond Herrmann

Units of the National Park System are described by park management and scientists as diverse, often unique, and having many individual resource information requirements. The often discussed Inventory and Monitoring (I & M) initiative is meant not to answer every individual park resource question, but to provide a level of management knowledge Servicewide that will allow for more directed study, problem analysis, and problem solution.

Today a number of persistent and troubling concerns exist at the park level that require us to develop a hierarchical strategy for obtaining information about processes important to resource decisions. If we examine the threats identified in the State of Parks Report 1980 and its 1987 successor, the Natural Resources Assessment Action Program, and then combine this information with a cursory review of programs in parks, we find a number of broad resource management issues that contribute to the structure of park I & M efforts:

1. life zone or biogeographic changes (viz. grizzly bear in Greater Yellowstone Ecosystem)
2. human encroachment (viz. recreation, industrial development, resource exploitation)
3. biogeochemical changes (viz. acid rain, carbon dioxide, the carbon cycle, trace elements)
4. global climate change, including
 - a. temperature change (viz. life zone changes, melting snow fields and glaciers)
 - b. mean sea level change (viz. shoreline erosion)
 - c. precipitation change – patterns and amounts (viz. flooding, drought)

Within this context, all parks, while not having identical information needs, do have some commonalities. We should observe and document those common "elements of change" for park systems or ecosystems to the degree necessary to interpret and analyze the cause or causes of change. Inventory of biotic and abiotic elements and documentation of important ecosystem processes and perturbations (viz. succession, floods, fires, wind, earthquakes, volcanoes, species migrations, biogeochemical cycle changes, etc.) precedes any understanding of how park resources may change. These required data are highly variable over time and space, primarily because the issues or questions driving Servicewide long-term inventory, monitoring and research programs have differing scales, such as local, regional and global.

Consequently, the complete I & M data set is difficult to define in advance. It is clear though that not all areas should be geo-observatories (or intensive study sites as part of a global network), but that all areas will have a data collection scheme to provide park management the information needed to understand, interpret, and manage effectively individual park "natural" resources within a regional and global framework.

The broad objectives articulated in the July 1987 "NPS National Resource Inventory and Monitoring Initiative," acknowledge the high level of uncertainty in planned data collection activities and establish the need for a "minimal" working program. Servicewide I & M of necessity reflects knowledge obtained from a number of additional programs (viz. UNESCO's Man and Biosphere program, National Science Foundation's Long Term Ecological Research program, the interagency National Atmospheric Precipitation Assessment Program), ongoing monitoring and inventory experiences (both within and outside NPS), and knowledge being obtained from a systematic implementation of the pilot NPS Inventory and Monitoring Program. In theory, this concept of park I & M might follow a 10-step process.

Steps 1-5 lead to completion of an inventory program:

- 1) identify problems and develop management objectives;
- 2) assign priorities;
- 3) examine existing background data and relevant literature;
- 4) develop working hypotheses, conceptual models and an inventory plan; and,
- 5) complete inventory to establish existing conditions (must include adequate quality control and quality assurance).

Steps 6-10 lead to implementation of a monitoring program:

- 1) select monitoring approach based upon ecosystem character (determine spatial and temporal relationships and system variance);
- 7) select appropriate monitoring sites and establish sampling frequency;
- 8) determine logistical needs;
- 9) complete and implement the monitoring program (including providing for summary interpretation of results, data quality assurance and quality control, and data management and storage); and,
- 10) revisit periodically, review and evaluate the monitoring program and its relationship to established objectives.

The Ecological Imperative

By Terence P. Boyle and Raymond Herrmann

Recent interest within the National Park Service for a more comprehensive and systematic inventory of natural resources and periodic monitoring to determine condition and to assess any man-induced changes has been manifested in the Natural Resources Assessment Action Program. Many parks have some resource inventory and monitoring (I&M) activities, however, many of these same parks are often at a loss to interpret collected environmental data when confronted with some of the more pervasive, complex threats to the integrity of their resources. In the past, many inventories of natural resources have been little more than lists of species and locations of samples sites; many monitoring efforts have been restricted to those mandated by human health concerns comprising a loose collection of assorted chemical constituents, often directed at concerns about water quality.

This article discusses the integration of management and technical aspects, and introduces a framework for conducting resource inventories and subsequent monitoring. Inventory and monitoring in the NPS is a responsibility shared between resource management and research. Therefore any program conducting environmental inventory and subsequent monitoring efforts should have certain critical elements that include: 1) a procedure for establishing clear co-responsibilities for resource managers and research scientists, 2) a concept of the ecological paradigm as a framework for the collection of information and interpretation of data in a resource inventory program, and 3) a rationale for using data generated in monitoring programs.

A primary role of resource managers is to secure information on threats and identify the needs for managing natural resources. Resource management needs should be put into a clear set of management objectives. It is the role of the research scientist to translate these management objectives into scientific hypotheses, data collection procedures, and conclusions. These two activities should be considered parallel and interacting.

I. The initial step is a clear statement of resource management programmatic concerns by the Park. These concerns may be mandated by legislation establishing the Park, come from pervasive threats such as pollution, result from land-use changes outside the Park boundaries, or be the consequences of management decisions. It is imperative that the statement of natural resource management concerns is both explicit and inclusive because it leads directly to and drives the other steps in the I & M process. This statement of concerns should be a joint effort between resource management and a research scientist. These individual resource management concerns should be arranged by priority to assign available resources.

II. The second step is the formulation of scientific tasks that are directly predicated from the resource management concerns in the first step. The set of scientific tasks should address the prioritized Park natural resources concerns, and in certain cases may also address broader issues that include long-term issues of regional or national importance. An explicit framework to implement these scientific tasks is as follows:

A) The scientific tasks should be in the form of explicit sets of testable hypotheses that address the Park specific and broader NPS resource management concerns.

B) These hypotheses will entail specific data set requirements. The level of effort in the data collection will be directly related to how the data will be used, i.e. for general

Continued on next page

Two requirements need additional emphasis: data management and data quality. Large quantities of data are being and will be produced by this program – uniform scaling and documentation is required. NPS has committed to a Geographic Information System. I & M data management is to be compatible and complementary. Detailed quality assurance and quality control plans, including accuracy and precision estimates, are needed for existing and future data sets that are to be incorporated into permanent data files. This will be a long, laborious process to integrate computing and analytic technologies into both the investigations and data collection aspects of the I & M process.

Development of site specific I & M plans is an important part of the coordinated collection of biotic and abiotic elements describing ecosystem processes of importance to park management. As previously stated, ecological processes occur at differing rates and in differing geographic patterns; some are thought to be geographically consistent at global or regional levels; while others are known to be locally site specific. To account for these differences, the NPS I & M program has incorporated a list of measurements or data sets relative to known agents of change. The resultant information base about park resources is proposed to be available to assist resources management in each park unit.

Invasive Exotic Plants And Their Management

Exotic pest plants, their biological and ecological implications, their social and economic impacts, and management initiatives for dealing with them are the subjects of a symposium slated for Nov. 2-4, 1988 at the Marine Sciences Center, University of Miami, Florida.

Word of the symposium comes from Robert F. Doren, Everglades NP Supervisory Botanist, who will welcome NPS registration forms mailed to Symposium Registrar, Exotic Pest Plant Council, Dan Beard Center, Everglades NP, P.O. Box 279, Homestead, FL 33030. Registration fee is \$45.

Plenary speakers will be Nathaniel P. Reed, former Asst. Secretary for Fish, Wildlife and Parks at the Department of the Interior, and Dr. Peter M. Vitousek of the Stanford University Department of Biological

Sciences. Dr. Vitousek will address "Biological invasion and ecosystem alterations" and Reed will speak on "A last ditch effort."

Speakers at the session on biology and ecology of invasive exotic plants will be from Florida, California, Hawaii, and New Mexico. Dominic Dottavio, who will chair the session on exotic plant management, has 12 papers scheduled that cover the subject in a variety of National Parks and from a wide range of strategies. Ronald L. Myers, Tall Timbers Research Station, The Nature Conservancy, will summarize the conference.

The symposium is being sponsored by the National Park Service, the Exotic Plant Council, the University of Miami, Florida's Division of Forestry, Fairchild Tropical Garden, The Nature Conservancy, and the U.S. Department of Agriculture.

Greenhouse Effect on Biological Diversity is Conference Theme

Late word received from NPS Natural Resources writer-editor Napier Shelton tells of an October 4-6 conference in Washington, D.C. on "Consequences of the Greenhouse Effect for Biological Diversity," convened by World Wildlife Fund - U.S., and six other sponsors, including the National Park Service.

Conference contact is Stacey Roberts, coordinating for the World Wildlife Fund, 1250 24th St., N.W., Washington, D.C. 20037. Shelton plans to attend the conference, and will prepare a report for the Winter issue of **Park Science**.

knowledge and interpretation vs. for legal defense of resources.

C) At this point there will be a comparison of resources available and costs against the prioritized list of natural resource concerns addressed. In effect, this step will determine what tasks can be done. Both resource managers and scientific personnel should reach a consensus on the content of the final scope of work.

D) The data collection should have a Quality Assurance and Quality Control program

in place before sampling takes place. This includes a precise statement of procedures of how data are to be collected, instrumentation used, use of chemicals or biological standards, and limits of detection.

E) There should be explicit plans for data storage, preservation, and archiving of appropriate samples. Considerations should be addressed as to who will be using the data and the time frame in which the data will be used.

F) The data should be subject to quantitative analysis that both establishes a basis for statistical parameters and forms a basis for accepting or rejecting the hypotheses generated by the resource management concerns.

G) Consideration of the final products in terms of written reports should be given before the inventory is begun. These products may range from a report written directly to the Park or the Regional Science Office, articles submitted to the peer reviewed literature, extensive materials covered in a monograph, or legal depositions and expert testimony.

This brief article cannot begin to cover inclusively all the technical aspects of inventories, however, these data should represent more than tabulations of data points in time and space. The NPS Resource Inventory and Monitoring Program must be designed to integrate the management concerns with a scientific/technical effort that identifies and quantifies key components of those resources with some level of ecological understanding that will allow both scientific comprehension and management interpretation. Here, we would like to introduce the term **ecological paradigm**, defined as a specific model or set of hypotheses encompassing comprehensive characterization of resources at the population, community, or ecosystem level of organization. There must be an ecological basis to the inventories that can explain changes in measured attributes of natural resources due to natural variability, naturally induced change, and man-induced change.

Examples of natural resource management concerns at different levels of biological organization and some of the technical aspects associated with specific ecological paradigms are found in Table 1.

Environmental monitoring of important natural resources is an extension of resource inventories. The same partnership and general procedures integrating management and scientific personnel in inventories should be developed to pose questions for monitoring programs. Resource managers are ultimately responsible for the questions posed by a monitoring program and final questions as to how the data will be used. Monitoring, by definition, is limited in magnitude and frequency of data collected. Resource management should be especially aware of the limits and conflicts inherent in any monitoring program. Two general opposing strategies of monitoring are 1) distinguishing departures from standard conditions, detections of violations of standards, or 2) establishing changes in conditions or key variables over time. These two contrasting activities have conflicting data requirements. Where resources are limited the environmental questions should be elaborated before the monitoring program begins.

This outline of technical aspects is not intended to be exhaustive of all possible aspects of natural resource inventories or environmental monitoring, nor should a resource inventory in a Park necessarily include all of the items elaborated in the lists. Inventory and monitoring in the National Park System is a relatively new concept and practice, and one that will vary among parks and evolve with time. These are essential steps that assign specific roles to resource managers and scientists to help insure useful knowledge in the managing of Park resources.

Herrman is Hydrogeologist and Boyle is Research Ecologist with the NPS Water Resources Division, Colorado State University, Fort Collins, CO 80523.

Table 1. Comparison of resource management and potential application of Ecological Paradigms in environmental inventories.

Management Inventory Needs	Ecological Paradigm
1) Single species population <ul style="list-style-type: none"> - fisheries - wildlife studies i.e. artiodactyls - carnivores - endangered species - pest species 	Population models <ul style="list-style-type: none"> - reproduction, growth, survival - Leslie matrix - structural analysis - analysis of limiting factors - inter-relationships competition, predation, etc.
2) Community <ul style="list-style-type: none"> - forest type - vegetation analysis - baseline data - environmental assessment 	Succession model & climax Structural analysis <ul style="list-style-type: none"> - diversity - dominance - similarity - stability Production <ul style="list-style-type: none"> - primary - secondary Biogeography <ul style="list-style-type: none"> - immigration/extinction - species equilibrium
3) Ecosystem Stream/watershed	River Continuum Concept <ul style="list-style-type: none"> - functional group analysis - carbon transport - detrital processing - photosynthesis/respiration ratio - discontinuity - nutrient loss
4) Lake/watershed	Trophic status <ul style="list-style-type: none"> - nutrient flux - nutrient loading - limiting nutrient Physical/chemical analysis <ul style="list-style-type: none"> - surface area - hydrological turnover - depth Energy fixation & flow

A Cooperative Approach to Water Quality Management

The Delaware River Experience

By Richard C. Albert and Elizabeth A. Johnson

Water quality management in any National Park System unit is a complex endeavor involving unique situations and a myriad of players. The two NPS units along the Delaware River: the Upper Delaware Scenic and Recreational River (UPDE) and the Delaware Water Gap National Recreation Area (DEWA) which includes the Middle Delaware Scenic and Recreational River, are no exceptions.

Separated by eight miles of the river, these two units are contained in three states (New Jersey, New York and Pennsylvania), two U.S. Environmental Protection Agency regions, nine counties and numerous municipalities. Both units are within commuting distance of the greater New York City area and rapid development is occurring adjacent to their boundaries. The excellent water quality, which is the basis for extensive river recreation, is threatened by direct and indirect discharge of treated wastewater into the scenic river reaches, and non-point sources.

This article describes the evolution of a cooperative water quality management program that is attempting to address the problems and issues inherent in the NPS units along the Delaware River. The partner in this endeavor is the Delaware River Basin Commission (DRBC), a four state-federal compact agency with broad water quality responsibilities. Cooperation with other entities in the NPS/DRBC program also is described.

Water Quality Monitoring

The cooperative monitoring program is an outgrowth of a DRBC program that began collecting water quality and biological data in 1969, and NPS concern for water quality within its two units. In 1981 DRBC conducted a water quality survey for input to the first draft Upper Delaware Scenic and Recreational River Management Plan and recommended that UPDE implement a water quality screening program instead of the limited fixed station monitoring then being proposed. The screen program was not implemented at that time.

Meanwhile, DEWA had instituted a beach monitoring program at several beach areas and was becoming concerned when occasionally high fecal coliform values were obtained. In 1982, therefore, DRBC conducted for the NPS an extensive water quality survey in the recreation area. This was the start of a DEWA and DRBC cooperative relationship which has continued to grow. In 1983 the two agencies cooperated in a study of a campground complex and developed a proposed joint NPS-DRBC water quality screening program for implementation in the recreation area on a trial basis. During the 1984 recreation season, 27 tributaries and 9 river locations were sampled weekly or bi-weekly. Evaluation of the program showed it to be effective.

The success of the 1984 trial program led to expansion of the program in 1985 to include the UPDE and the eight miles of intervening river. During the 1985 recreation season, baseline data were acquired on 88 tributaries and river locations. A sampling frequency of weekly to biweekly was maintained with the result that a total of 550 station-visits were made by NPS (DEWA and UPDE) and DRBC personnel. In 1986, 406 station-visits were made to 93 sampling sites and, in 1987, 340 station-visits were made to over 70 locations. The decline in station-visits reflects some reorientation of the program to priority areas and to special studies such as the 1987 sediment toxics survey, which sampled 17 locations.

The latter was funded jointly by the Mid-Atlantic Region and DRBC.

The philosophy of the water quality screening approach program is to conduct extensive areawide sampling with few parameters but frequent sampling and many sampling sites. Eight primary parameters are used to obtain water quality "fingerprints": fecal coliform, fecal streptococcus, dissolved oxygen, pH, conductivity, water temperature, rainfall, and benthic organisms. Numerous water quality problems have been identified by this method and a baseline suitable for evaluating trends has been obtained.

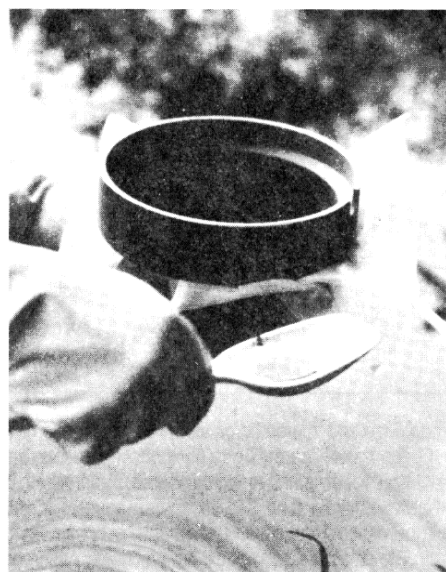
Cooperation with other monitoring agencies is obtained in four primary ways:

1. through normal day-to-day interactions between agency staff;
2. through the publication of annual reports of findings, which solicit state follow up surveys where problems are noted;
3. by providing assistance to other programs when requested; and,
4. through the periodic conduct of water quality workshops.

A water quality workshop in 1988 was attended by approximately 50 persons representing federal, state, and local governmental agencies and citizen organizations that operate in the scenic rivers area. The purpose was to learn what is being done in the region and how the different organizations could help one another. The NPS-DRBC program has obtained good cooperation from other agencies by designing a program that augments their existing monitoring efforts and offers services that are useful to them (e.g., the annual reports, periodic workshops and the 1987 toxics survey).

Scenic Rivers Water Resources Management Planning

While serving a useful function, water quality monitoring does not prevent water quality problems from occurring. In the Delaware River NPS units, particularly



St. Anthony Falls hydraulic lab sieve, used to collect sediment samples for toxics analyses. This sample in the Upper Delaware Scenic and Recreational River was very high in arsenic.

DEWA at this time, potential pollution from sources outside of park boundaries is a critical issue. For example, a new treatment plant recently began discharging into the 8-mile section of river between the Upper and Middle Delaware Scenic and Recreational Rivers. More recently, DEWA received the first two of potentially many requests for right-of-way permits to cross NPS land in order to discharge significant quantities of wastewater into the Middle Delaware Scenic and Recreational River. The increase in development also raises concern for non-point sources. A joint NPS-DRBC scenic rivers planning effort for DEWA has, therefore, been initi-



Future water quality problems could jeopardize scenes like this.

ated to address both current and future water quality issues and possible management changes.

In order to develop the DEWA water quality management plan, a formal Memorandum of Understanding was signed by the DRBC and the NPS (DEWA and Water Resources Division). Major input to the planning process will be obtained from the local, county, state and federal agencies operating in the three-state area draining to DEWA. State and federal participation will be accomplished through use of the DRBC Water Quality Advisory Committee and personal contacts.

The objectives of the joint planning effort are predicated on the fact that (1) the Middle Delaware Scenic and Recreational River could be classified by the states and DRBC as an "Outstanding National Resource Waters" as defined by U.S. EPA anti-degradation policies, (2) its National Wild and Scenic Rivers designation mandates special concern for water quality protection, (3) existing water quality is generally higher than required by existing standards, and (4) the recreational use of the river requires high levels of water quality. If existing water quality standards, programs and anti-degradation policies do not adequately protect existing or future water quality, potential management recommendations will be developed by the planning process and recommended for implementation by the various water quality agencies, including DRBC.

In order to focus the water quality management planning effort, descriptive land use themes have been detailed on mylar overlays to USGS 7.5 min quadrangles. These themes include existing property lines, watersheds, proposed and active development, open areas, wetlands, public lands, and zoning for townships adjacent to the park. A DBase III program is being developed to describe attributes of these themes. The attributes will include numbers of structures, land use (commercial, residential, etc.), population densities, and types of water and sewer. These will be used to analyze the amount of development (and pollution) that will or is occurring in a particular watershed in order to pinpoint potential problems for existing and future conditions. These spatial data will become part of a geographic information system currently being established at DEWA. The GIS will be used with water quality assessments (including the development of a predictive model) and assessments of the existing management functions of various levels of government in order to develop recommendations. It is assumed that policies, recommendations, and potential water quality standards that are developed by the DEWA planning effort may be applicable to the UPDE as well.

Summary Conclusions

The NPS Delaware River units are involved with the

book review

Damming the Delaware: The Rise and Fall of Tocks Island Dam. Richard C. Albert. 1987. The Pennsylvania State University Press. University Park, PA. 202 p.

The Delaware River is neither a large river nor a long river. Its drainage area is modest and it lacks some of the grandeur of the world's "great" rivers. Yet, this river has contributed significantly to the history of this nation. Indeed, if the Delaware River hadn't served as an obstacle to the British pursuit of General Washington's army after the fall of New York City, many of us might be collecting our paychecks from Britain's Countryside Commission rather than the National Park Service!

Today, the mainstem of the Delaware River remains undammed, despite the fact that the river and its tribu-



Field test being conducted on Delaware River water by a Delaware River Basin Commission staff member.

Delaware River Basin Commission in a cooperative program that is becoming increasingly sophisticated. This program is mutually beneficial and cost-efficient. The cooperation has been successful because: (1) each agency is accorded equal partnership status; (2) common objectives are recognized; (3) a spirit of cooperation exists among all agency participants; (4) the program has been allowed to evolve naturally in response to resources and concerns; and (5) the program is designed to complement the programs of other agencies.

Albert is Supervising Engineer, Water Quality Planning and Analysis Section, Delaware River Basin Commission. Johnson is Resource Management Specialist, The Delaware Water Gap NRA.

Additional Reading

Albert, R.C. "Effective Low-Cost Area-wide Water Quality Monitoring." In Lake and Reservoir Management, Volume II. North American Lake Management Society, 1986.

Delaware River Basin Commission. Report No. 10 Upper Delaware Summer Limnological Program. Prepared in cooperation with the National Park Service. Includes findings of 1987 baseline and toxics sampling and the DRBC-NPS Memorandum of Understanding for development of the DEWA water resources plan. 1988.

taries provide drinking water to more than 10 percent of the U.S. populations. Situated along the borders of the populous states of New York, New Jersey, Pennsylvania and Delaware, the river also serves as an exceptional recreation resource within easy reach of more than 20 million Americans. Two units of the National Park Service, Delaware Water Gap National Recreation Area and Upper Delaware Scenic and Recreational River, are located along the upper and middle reaches of the mainstem of the Delaware River.

Damming the Delaware is a fascinating account of 200 years of water management. The history of the Tocks Island Dam project, which was to have created a major reservoir in what is now Delaware Water Gap National Recreation Area, is traced from an early 1783 anti-dam treaty, through multiple U.S. Supreme Court decisions (1931, 1954) and a highly emotional 1970s environmental controversy, to a historic "Good Faith" agreement, in which the four states within the Delaware

2 New Pubs Discuss 1987 NRM Highlights, Air Quality Findings

"Only a sampling" of the natural resources management activities conducted in National Park sites during FY 1987 is presented in the newly published *Highlights of Natural Resources Management*, according to Editor Donna O'Leary of the NPS Air Quality Division in Denver. But the brief accounts contained are intended to represent the Service's diverse natural resource management activities. For those desiring more detailed information on a particular project, contacts are listed in the 54-page report.

Air Quality in the National Parks, a summary of findings from the NPS Air Quality Research and Monitoring Program, is a nearly 100 page document that details the Program's responsibilities and activities, describes "visibility," discusses effects of visual air quality on visitor experience, discusses criteria pollutants in NPS units, reports on air pollution effects on biological resources, and reviews NPS participation in protection of air quality resources.

Twenty-three figures, many in full color, and a fold-out table of the visual range at NPS visibility monitoring sites from Summer 1978 to Fall 1984 are included.

We Promised It – It's Almost Ready

Natural Resource Publications Coordinator Donna O'Leary is putting the final touches on a new directory of NPS personnel who spend 50 percent or more of their time in research and/or natural resource management.

Remember that old yellow book with the owl, the whale, the fox and the bighorn sheep on the cover? The one that said 1980 Science and Technology Directory? That's the one you can throw away now along with all the scotch tape that's been holding it together for the past 4 or 5 years.

Furthermore, Donna promises an update every year. Personnel will be listed by name, by region (and WASO), by title, and by discipline, for easiest access no matter what your need.

Distribution will be made through each Region's Chief Scientist.

River basin derived a new formula for the equitable apportionment of the basin's water. The book provides insight into the water politics of four states (New York, New Jersey, Pennsylvania, and Delaware), two cities (New York City and Philadelphia), and the federal government, as well as the influence of the environmental movement over major public works projects. The book also provides a history of the establishment of the Delaware Water Gap National Recreation Area and the Middle Delaware Scenic and Recreational River, the latter of which was created to keep the Tocks Island Dam from being built in the National Recreation Area.

Damming the Delaware is a thoroughly researched and well written synthesis of public record, which serves as an invaluable political case study. As such, it should be of interest to National Park Service policy makers and managers as well as to water resource professionals.

Mark D. Flora

NPS Water Resources Division

Fifth Triennial Conference on Research in the National Parks and Equivalent Reserves and Third Triennial Meeting of the George Wright Society

By Kathy Hiatt and R. Roy Johnson

The Fifth Triennial Conference on Research in the National Parks and Equivalent Reserves and Third Triennial Meeting of the George Wright Society, will be held Nov. 14-18, 1988, at the Holiday Inn-Broadway, 181 W. Broadway, Tucson, AZ 85701, in cooperation with the National Park Service. Friday afternoon, Nov. 18, has been reserved for groups wishing to hold post conference meetings. Saturday, Nov. 19, has been set aside for an optional field trip to Organ Pipe Cactus National Monument (an International Biosphere Reserve). Co-sponsors of this year's conference and meeting include: National Parks and Conservation Association (NPCA), Friends of Pronatura, American Water Resources Association, and the North American Riparian Council.

The George Wright Society is a non-profit, inter-institutional, educational, and scientific organization dedicated to the protection, preservation, and management of cultural and natural parks and reserves through research and education. To aid in these goals the Society publishes the *Forum*, a quarterly journal in which members and others may contribute and exchange articles, philosophies, and ideas related to these areas.

This year's conference will stress the role of natural sciences, anthropology, social sciences, and history in the protection and enjoyment of natural and cultural resources in parks and reserves. The theme is "Parks and Neighbors: Maintaining Diversity Across Political Boundaries." Sessions include plenary, mini-symposia, workshop, and poster and will be conducted by representatives selected from natural and cultural resource management, sciences and interpretation, and operations and administration. Topics will cover inventory and monitoring, resource management, interpretation of cultural and natural resources, global change, parks and adjacent lands, biodiversity, cultural diversity, recreation and sociology. The published proceedings will consist only of plenary session papers. Abstracts will be required with the submission of mini-symposia proposals and for contributed papers for the poster sessions.

A presentation by NPCA Vice President (for Conservation), Destry Jarvis and the NPCA Commission on Research and Resource Management Policy in the NP System is one of the featured events. Following an open plenary session with NPCA and the Commission, workshops will provide dialogues on various aspects of the Commission's findings and their 1988 report. The second afternoon of the conference will include a field trip to Saguaro National Monument to examine local land use issues and problems facing park personnel, researchers, and adjacent urban developers. The 1988 NPS Resource Management Trainee Class will be attending this year's conference as part of their curriculum. An evening, special emphasis, resource management workshop session has been programmed with speakers Ro Wauer, Virgin Islands, founder of the Resource Management Trainee Program and Tom Gavin, Western Region, who has proposed forming a resource management section of the George Wright Society.

Authors of recent books on the National Park Service, former NPS Director, George B. Hartzog and Dr. Alston Chase will present plenary addresses to conference participants as well as open public sessions about their books. Regional Chief Scientists and all

NPS-CPSU Unit Leaders will hold meetings also, in conjunction with the fall conference.

Participation by agencies and persons outside the NPS is encouraged. Early registration for attending the conference is due by Oct. 15. For further conference information and registration procedures please contact either Roy Johnson or Kathy Hiatt c/o National

Park Service-CPSU/UA 125 Biological Sciences-East, University of Arizona, Tucson, AZ 85721, or by calling (602) 629-6896 or (602) 621-1174. For Cultural Resources information, contact: Dr. Melody Webb c/o National Park Service-Southwest Regional Office, Old Santa Fe Trail, P.O. Box 728, Santa Fe, NM 87501 or phone FTS 476-1787.

Conservation Biology in Hawaii Gets Initiative Support

NPS scientists Chuck Stone and Lloyd Loope were among 16 invited participants at the inaugural meeting on June 1-2 in Honolulu of the Hawaii Conservation Biology Initiative (HCBI), hosted by The Nature Conservancy of Hawaii (TNCH). Initiation of this program was made possible by a \$500,000 grant to TNCH by the John D. and Catherine T. MacArthur Foundation. As envisioned by the TNCH proposal to the MacArthur Foundation, HCBI will be a project shaped by the Hawaiian and international conservation communities, for which TNCH will serve as a "catalyst." Its aim is at fulfilling an urgent need for promoting and coordinating conservation-related research throughout Hawaii.

Meeting participants supported the concept of regarding the \$500,000 MacArthur grant as "seed money" for a much larger project that will depend on active participation of many individuals and agencies

involved in Hawaiian natural resource conservation. Initial funding will be used 1) to begin to develop a network of research stations to support conservation biology in the islands and 2) to provide seed money to initiate important research projects. One appointed committee will investigate how and where to proceed with the research station network. Another will refine a process for the program of conservation research grants, requesting proposals in September and reviewing them in January 1989. A third committee will investigate further the appropriate bureaucratic structure of HCBI.

Participants were optimistic about possibilities for obtaining funding to support greatly expanded research on Hawaiian conservation biology. Scientists within the islands and on the mainland can be recruited for this work given a reasonable amount of funding and logistical support.

meetings of interest

1988

October 11-13, SAGIS/GRASS USERS CONFERENCE FOR NPS PERSONNEL, at Shenandoah NP. Contact: Allison Teeter, Shenandoah NP; (707) 999-2243.

November 2-4, EXOTIC PEST PLANTS, THEIR BIOLOGY, ECOLOGY, AND MANAGEMENT, at University of Miami, Marine Science Center; Contact, Robert F. Doran, Dan Beard Center, Everglades NP, P.O. Box 279, Homestead, FL 33030.

November 10-13, THIRD CHIHUAHUA DESERT SYMPOSIUM, at Sul Ross University in Alpine, Tex. Contact: John Bissonnette, professor of wildlife research, Utah State Univ., Logan, UT 84322-5210.

November 14-18, CONFERENCE ON SCIENCE IN THE PARKS, sponsored by the George Wright Society in cooperation with the National Park Service and co-chaired by R. Roy Johnson, Leader of the NPS/CPSU at University of Arizona, Tucson, AZ 85721, (602) 762-6501 and James Judge, Director, Fort Burgwin Research Center, P.O. Box 300, Ranchos de Taos, NM 87557, (505) 758-8322.

1989

March 8-10, TENTH ANNUAL PARK AND RECREATION ENFORCEMENT AND VISITOR PROTECTION WORKSHOP, at Illinois Branch State Park, Zion, IL, conducted by the Texas Agricultural Extension Service, Texas A & M at College Station, TX 77843-2261. Contact Bruce E. Wicks, (409) 845-5418.

March 15-18, LINKING LANDSCAPE STRUCTURE TO ECOSYSTEM PROCESSES, the Fourth Annual Landscape Ecology symposium, sponsored by the U.S. Regional Assn. of the International Assn. of Landscape Ecology, at Colorado State Univ., Fort Collins. Contact: Dr. Ingrid C. Burke, Natural Resources Ecology Lab, Colorado State U, Fort Collins, CO 80523. (303) 491-1620. November 15, 1988 is the deadline for abstracts.

May 18-20, RESTORATION AND PRESERVATION OF GREAT LAKES COASTAL ECOSYSTEMS. Sponsored by Indiana Dunes National Lakeshore and Illinois-Indiana Sea Grant; chaired by Ron Hiebert; at Indiana Dunes NL, 1100 N. Mineral Springs Rd., Porter, IN 46304; (219) 926-7561.

regional highlights

Rocky Mountain Region

A regional Research Catalog containing a listing of all natural, cultural and social science research needs has been printed and distributed. All regional NPS units listed specific research needs as well as available facility and administrative support within the park. The idea is to request "free" help from outside agencies, universities, and the private sector in resolving park research related issues. A limited number of copies are available from Dr. Robert Schiller (303-969-2652, FTS-327-2652).

A peregrine falcon monitoring workshop was held on April 18-22 in Grand Junction, Colo. Approximately 50 participants represented NPS units in the Rocky Mountain and the Southwest Regions, as well as BLM, USFS, FWS, and the States of Colorado and Utah. Workshop objectives included a discussion and presentation of field techniques, discussion of population status, and specific peregrine falcon projects. The workshop included supervised field work in searching for new eyries and observing occupied sites while participating in annual field and monitoring surveys. The workshop may be repeated at intervals over the next few years.

The Rocky Mountain Region is pleased to announce establishment of a new NPS Cooperative Park Studies Unit at Colorado State University, Fort Collins. The director will be responsible for the science program for all NPS units within the state of Colorado. An announcement for the position will appear this fall.

From Cliff Martinka, Chief Scientist at Glacier NP, comes a letter with a handsome brown card: "Thought you might be interested in our attempt to develop and communicate an organizational philosophy for science." The card, actual size 2" x 4", is shown here.

A Science Philosophy

SCIENCE IS PERVASIVE.
PEOPLE ARE FUNDAMENTAL.
COMMUNICATION CREATES VALUE.
EXCELLENCE IS LASTING.



Glacier National Park
August 1988

Tennessee CPSU Gets New Leader

Dr. Stephen C. Nodvin has been appointed director of the Cooperative Park Studies Unit at U/Tenn, Knoxville. Nodvin, 35, most recently served as assistant research professor of ecology in the Dept. of Geological Sciences, U/Maine, Orono. He has worked on studies varying from the chemistry of pristine lakes in the High Sierra of California to the effects of forest disturbance on land snails in New England. His papers have appeared in zoology, soil science and water resources journals. Of the proceedings and publications he has written, several deal with the effects of acid precipitation.

Nodvin earned a bachelors degree in biology at Emory University in Atlanta, and his PhD in ecology and evolutionary biology in 1983 at Cornell University, Ithaca,

NY. He served for four years as an assistant research scientist in the Dept. of Soil and Environmental Sciences at U/Cal, Riverside, and briefly as a research consultant for Syracuse University. Nodvin replaces Peter S. White, who transferred to U/NC, Chapel Hill, over a year and a half ago.

Midwest Region

Mike Ruggiero, formerly Chief Scientist of the Midwest Region, became chief of the Wildlife and Vegetation Division at NPS headquarters in Washington, D.C. on August 1. Gary Willson, Regional Ecologist, will be acting Chief Scientist until the position is filled.

As the result of a 3-year study of rare species in 19 Midwest Region parks, the Regional Science Office has initiated the following research projects designed to provide parks adequate baseline information on the distribution on biology of selected rare species:

Evaluation of piping plover habitat in National Park Units in the Great Lakes Area; reintroduction of peregrine falcons to Isle Royale; distribution, abundance, and habitat analysis of freshwater mussels of the Saint Croix and Namekagon, Saint Croix; determination of cave ground-water sources in three caves with endangered bats at Ozark; population ecology and management recommendations for *Lesquerella filiformis* at Wilson's Creek; mapping and monitoring of populations of *Cirsium pitcheri* at Pictured Rocks, Sleeping Bear Dunes, and Indiana Dunes; and population regulation in Isle Royale wolves.

The sociology project crew, consisting of Becki Van-Cleave, Bill Beard, and Brian Daum, has been collecting trail use data over the past three months on a variety of trail segments. Day use patterns are being monitored along 7 trails and locations. Monitoring equipment includes pressure sensitive mat counters buried in the trail, electric eye counters, and electric eye-triggered cameras. Questionnaires are collected at trailheads and parking lot counts were taken at hourly intervals. A protocol is being developed for use of remote monitoring equipment for long-term, parkwide monitoring of trail users as part of the larger Inventory and Monitoring of Human Resources program.

Pacific Northwest

A reprint from *Northwest Science* (Vol. 61, No. 4, 1987, 220-225) on "Roosevelt Elk Density in Old-Growth Forests of Olympic NP" is available from Olympic NP, 600 E. Park Ave., Port Angeles, WA 98362. The authors, D.B. Houston, B.B. Moorehead, and R.W. Olson, describe and evaluate two years (1985-86) of censusing Roosevelt elk from a helicopter in the dense old-growth forests of Olympic NP.

A mammoth tusk, dated from 10,000 to 40,000 years ago (give or take a few thousands) was stumbled on by a dental technician from Eugene, Ore., during a Memorial Day weekend hike along Bridge Creek, 3 miles south of the Painted Hills Unit of John Day Fossil Beds National Monument. Merle Simmons, who spotted the tusk sticking out of the earthen creek bank, called John Day and contacted Ted Fremd, NPS museum specialist/paleontologist, who helped stabilize the find.

Fremd notified Archeologist Suzanne Crowley-Thomas of the Bureau of Land Management, on whose land the fossil was discovered. NPS had signed in 1987 a cooperative agreement with BLM, under which NPS provides curatorial and paleontological services for

management of fossil resources found on BLM lands within the John Day basin and BLM provides specimen cabinets in which the finds are kept at park headquarters in dedicated storage rooms.

The comparatively recent age of the mammoth tusk (thought to belong to a Columbian mammoth – somewhat larger than the woolly mammoth) makes it of little interest to the John Day collection, but Fremd contacted a Portland State University paleontologist, David Taylor, who is planning to set up a Northwest Museum of Natural History, where the tusk might eventually be displayed. BLM lands – especially those north of the John Day Fossil Beds NM's Sheep Rock Unit – are rich in ancient fossils, and the BLM-NPS agreement is facilitating the handling and disposition of finds in these areas.

The 1987 Annual Science Report for the Pacific Northwest region is now available from Ron Hyra, editor, Pacific NW Region, NPS, 33 King St., Seattle, WA 98104. The 145 page document lists all research that has taken place in PNR parks, publications that have resulted from this research, and the names and addresses of investigators.

Water Resources Division

A workshop on the effects of acid rain and air pollutants to desert park areas was held in Tucson May 16-18, 1988, coordinated by the Water Resources and the Air Quality Divisions and designed to determine what is and is not known about the effects of air pollutants on desert natural and cultural resources.

The 31 who attended included representatives from 17 parks and 3 regional offices. Major concerns dealt with the following: The sizeable but unquantified amount of dry deposition of sulfur and nitrogen oxides; the virtually unknown but potentially serious effects of ozone, sulfur, and nitrogen oxides and acid rain on desert plants; the possibility that the ephemeral aquatic habitats found in desert potholes also are at risk.

Monitoring and bioassay experiments to determine the effects of air pollutants on these and cultural resources were recommended. A proceedings from this workshop will be produced through the WASO Office of Natural Resources.

Jill Baron, a Research Ecologist with the Water Resources Division at Fort Collins, will be on sabbatical through July 1989. The sabbatical, arranged through Colorado State University, is designed to allow Baron to write a monograph on the results of an eight-year research project having to do with effects of acidic atmospheric deposition on the biogeochemical processes of Loch Vale watershed, an alpine/subalpine drainage in Rocky Mountain NP.

Southeast Region

In his article "Restoring the Bald Eagle" (*American Scientist*, May-June 1988 issue), NPS Research Biologist Ted Simons describes the efforts of a cooperative project involving the Sutton Avian Research Center, the states of Florida, Georgia, Alabama, Mississippi, Oklahoma and North Carolina, the University of Florida, the USFWS and NPS to restore populations of bald eagles (*Haliaeetus leucocephalus*) in the southeastern U.S. The project is divided into three phases – egg recycling, captive propagation, and hacking – and seeks to establish 90 new nests in the Southeast, according to USFWS's Southeastern States Bald Eagle Recovery Plan. Gulf Islands NS, where Simons is stationed, is one of five hacking sites under the program.

Continued

Regional Highlights, *Continued*

Simons, the Gulf Islands, and the southeastern bald eagle restoration project also are the focus of a full-color feature article published in the national *Life* magazine ("Into the Air, Little Baldies!" by Michael Wallis, May 1988 issue). Copies of both the *American Scientist* and *Life* articles can be had by writing to Ted Simons, Gulf Islands National Seashore, 3500 Park Road, Ocean Springs, MS 39564.

In cooperation with the USDA Forest Service's Spruce Fir Cooperative, GRSM researchers have been involved in an intensive ongoing study of the effect of atmospheric pollutants on eastern spruce-fir ecosystems. The 66 permanent vegetation plots established within the park will provide resource managers with site-specific information on the biological health of the park's 18,000 acres of spruce-fir forests. Plots are in their fifth consecutive year of evaluation; annual data on growth, mortality, foliar symphonology, and regeneration success will be analyzed this fall.

Spruce-fir crews also have been documenting occurrence of rare and endangered plant populations indigenous to high elevation forests. This information is being forwarded on to appropriate personnel for inclusion in the park's new Natural Heritage Data Base.

To provide "ground truth" for a vegetation type map made from Landsat Imagery, a crew of six people sampled vegetation (trees only) at approximately 270 nonpermanently marked points in GRSM, divided equally among three topographic quadrangles in the eastern, western, and central portions of the park. The data will be analyzed (a) to derive vegetation type names for the 14 types depicted in the satellite imagery, and (b) to describe the species variability within each of the designated vegetation types.

Scientists and resource managers in the Caribbean and Western Atlantic are working together on a 3-5 year project funded primarily by the NPS to establish long-term assessment programs for coral reefs under NPS jurisdiction in Florida and the U.S. Virgin Islands as a basis for more effective management. In April 1988, Dr. Caroline S. Rogers, Research Scientist for the Virgin Islands NP, coordinated a meeting of 25 scientists and managers of marine protected areas to discuss priorities for long-term monitoring and to recommend appropriate methods and approaches. It was agreed that long-term assessment of coral reefs should take place at three levels: 1) routine gathering of data on basic environmental parameters such as temperature, salinity, and turbidity; 2) tracking of benthic reef organisms with a combination of photographic and transect/quadrat methods and documentation of fish populations; and 3) experimental research on system components following detection of change. Recent Caribbean-wide events have underscored the need for a regional, long-term approach to reef studies. Better understanding of reef dynamics will help in differentiating human and natural causes of disturbance.

On July 9-10 the Southeast Region held a workshop to discuss sea turtle management objectives. Participants (ranging from Natural Resources Management Specialists to Interpreters) discussed sea turtle biology, nest protection, research and strandings in the parks. There are 11 parks in the region that play a role in the recovery

of sea turtle. The USFWS's sea turtle coordinator from the southeast participated.

Florida panther research is being expanded to include Big Cypress in FY89. Panther research in Everglades is continuing as planned. This year we radio-collared one additional adult female to bring the radio-collared total to six. Unfortunately, this year, one adult female died of natural causes and one sub-adult female was hit by a motor vehicle outside of the park. The physical recovery of panther #23 is going well and we hope to place her back into the wild.

Stephen Cofer-Shabica, Oceanographer, was transferred from Biscayne NP to the NPS Cooperative Park Study Unit at the University of Georgia. Stephen is coordinating a five-year \$4.8 million monitoring program at Cumberland Island NS. The U.S. Navy funded program is a multi-agency effort required because of the Kings Bay Naval Station being built adjacent to Cumberland Island.

From John Peine, Associate SERO Director for Science and Natural Resources, come the following highlights from Great Smoky (GRSM) Mountains NP:

The ozone fumigation project, now ending its second year, is an attempt to determine the extent of ozone pollution and its effects on many of the 1,500 native plant species found in the park. Scientists at Uplands Field Research Lab, funded by the NPS Air Quality Division, are working with Jim Renfrom, lead biological technician on the project. Ozone injury has been recorded on nearly 20 species and plans are to collect specimens and expose them to the four treatments of ozone to verify the injury as ozone-caused. Species targeted for testing in 1989-90 include Fraser magnolia, black cherry, sassafras, yellowwood, black locust, basswood, sweetgum, sycamore, milkweed, coneflower, blackeyed Susan, dwarf dandelion, galax, blackberry, huckleberry, Caly's bentgrass, flame azalea, and clematis.

From Jim Wood, NPS technical publications editor, comes word that two new Servicewide scientific monographs are now in press and will be available for distribution this Fall:

Scientific Monograph Series No. 18, **Visual Preferences of Travelers Along the Blue Ridge Parkway** by Francis P. Noe and William E. Hammitt.

Scientific Monograph Series No. 19, **The Forest Communities of Mount Rainier National Park** by Jerry F. Franklin, William H. Moir, Miles A. Hemstrom, Sarah E. Greene and Bradley G. Smith.

Mid-Atlantic Region

The Region welcomes Chris Andress as its new Chief of the Division of Resource Management and Visitor Protection. Chris formerly was Chief Ranger at Petrified Forest NP. We also welcome Gordon Olson to the post of Resource Management Specialist at Assateague Island NS and Chuck Barat as Resource Manager at Petersburg National Battlefield.

Researchers are closely monitoring effects of West Virginia's efforts to control black flies in the region around New River Gorge National River. Over NPS objections, special legislation initiated by Senator Byrd of West Virginia approved the spraying of Bti, a bacterium, for up to 8 years over the New River within park boundaries. Researchers are evaluating effects of these

weekly applications on non-target species, secondary aquatic productivity, and fish growth.

An incorrect address was given in the Summer issue of **Park Science** for obtaining the publication "Inventory and Impact Monitoring for River Campsites Within the Delaware Water Gap NRA." The correct address is Jeff Marion, Star Route 38, Milford, PA 18337.

Western Region

From Charles Douglas, unit leader of the CPSU at U/NV-Las Vegas, comes word of five technical reports now available:

Leary, P.J. 1988. *Plant succession after fire, Hunter Mountain, Death Valley National Monument II*. CPSU/UNLV No. 034/06, 20 pp.

Longshore, K.M. and C.L. Douglas. 1988. *Vegetational recovery following burro removal in Death Valley National Monument*. CPSU/UNLV No. 035/04, 36 pp.

Leary, P.J. 1987. *Survey of endangered plants, Joshua Tree National Monument*. CPSU/UNLV 037/01, 26 pp.

Douglas, C.L. and H.D. Hiatt. 1987. *Food habits of burros in Death Valley*. CPSU/UNLV 006/46, 25 pp. *Annual Report*. 1987.

Clifford Smith, Director of the U/Hawaii CPSU, reports publication by the CPSU of *Freshwater Birds* by Winston E. Banko. The History of Endemic Hawaiian Birds, published as Report #12, is in four parts: 12A, Hawaiian Gallinule 'Alae-ula. 138 pp.; 12B, Koloa-maoli. 165 pp.; 12C, Hawaiian Coot 'Alae-ke'oke'o. 206 pp.; and 12D, Hawaiian Stilt Ae'o + Bibliography. 421 pp.

Donald Gardner, research scientist at the NPS/CPSU, Univ. of Hawaii, spent April-August 1988 on temporary duty at the Dept. of Plant Pathology at NC State Univ., Raleigh, NC. Gardner is a plant pathologist working on biocontrol of alien plants in Hawaiian parks.

The noxious bramble species most widespread in Hawaii was introduced from the southeastern U.S., where it is attacked by a rust fungus disease. Gardner took cuttings from the Hawaiian population, as well as those of two endemic Hawaiian *Rubus* species, to North Carolina, where he evaluated the ability of the disease to attack this material. Potential biocontrol agents for fayate, originally from the Azores and Madeira and a close relative of wax myrtle in the Southeast, and broomsedge, a bunchgrass also native to North America, are being sought. Both fayate and broomsedge are aggressive weeds in Hawaiian parks.

Interpretive Specialist Marty Lane and Research Scientist Chuck Stone (Hawaii Volcanoes NP) presented sessions on the park at NPS Critical Natural Resources Issues course at Mather Training Center in May. They had taught the course in 1987 also, but this time they assisted course director Dave Dahlen with course logistics as well. The course placed special emphasis on biodiversity, with discussions and case histories of other resource issues. Stone and Lane are presenting sessions on Island Biology at the NPS Interpretive Conference in San Diego in October.

From Dave Parsons, NPS Research Scientist at Sequoia-King's Canyon NPs (SEKI), we hear:

"Our ongoing Cooperative Agreement on Giant Sequoia Fire History with the Laboratory of Tree Ring

Continued

information crossfile

A recent issue of *BioScience*, 38(7), is devoted to biological diversity conservation and contains an article by Christine Schonewald-Cox, NPS Research Scientist at the U/Cal Davis CPSU. She presents a conceptual model to show how many natural reserves have shrunk in the face of developments, human competition for resources, and changes in political ideologies. Examples from Redwoods NP in California and Organ Pipe Cactus NM in Arizona suggest that "buffer areas" outside reserves are required to maintain the integrity of natural resources and processes within the reserves.

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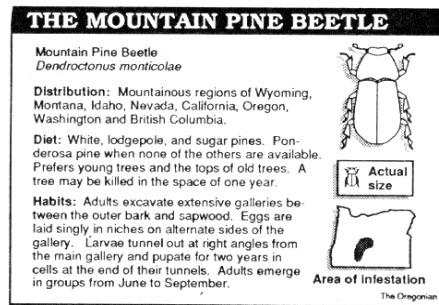
Nature can present some really knotty, frustrating, circular problems.

A beetle not much bigger than a grain of rice is busy chewing up the trees in a 1.4 million acre area of Oregon and parts of Washington. The Mountain Pine Beetle (*Dendroctonus monticolae*) lives in mountainous regions of Wyoming, Montana, Idaho, Nevada, California, Oregon, Washington and British Columbia and dines primarily on white, lodgepole, and sugar pines. Last year about 1.6 million acres of lodgepole, ponderosa and white pine were killed by the beetle in Oregon and Washington, according to Iral Ragenovich,

entomology group leader for the PNW region of the USFS. The current outbreak began about 20 years ago and is being contained by thinning of dense tree stands to slow the beetle's spread.

The long-term solution involves better management of lodgepole pine, white pine, and second growth ponderosa pine. The beetles thrive on old, dense stands of such trees, so managers need to keep stands thinned. In the past, forest fires have helped thin lodgepole stands and keep beetle populations down. Ironically, better forest fire fighting and prevention have helped preserve the Northwest's second growth stands and this, in turn, has helped the mountain pine beetle kill those same trees and spawn more forest fires.

Steve Woodward of the (Portland) *Oregonian* staff put together this picture of the tree-slayer.



From Oregon's Department of Fish and Wildlife comes a news release entitled "Peregrine Recovery

Takes Wing," describing the most successful summer in decades for the production of peregrine chicks in the state. Biologists estimate that at least six nests produced chicks in 1988 for a possible total of 16 additional new birds.

The Department's expenditure for peregrine recovery this year amounted to \$9,000, spent in conjunction with \$22,000 from other agencies (NPS and USFS) and the Peregrine Fund. The work dovetails with programs in neighboring Washington and California.

At Crater Lake NP, in a complicated scenario involving natural nesting, death by horned owl, and substitution of facility-born peregrine chicks into a prairie falcon nest, two chicks may have "made it" this year. (The story will be told in detail by Jim Milestone in the Winter issue of *Park Science*.) Elsewhere, the birds are being raised in hatch boxes in Hells Canyon, the lower Columbia River Gorge, and at a new site near Summer Lake in Oregon.

Department spending for the last seven years of reintroduction efforts is near \$100,000; all of this money has come from donations by Oregon state taxpayers to the Nongame Wildlife Fund on the state tax form.

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The Second US-USSR Symposium on Air Pollution Effects on Vegetation was held in September (1988) at three locations in the U.S. - Corvallis, Ore., Gatlinburg, Tenn., and Raleigh, N.C. At Corvallis, the theme was dendrochronology as a tool to evaluate temporal patterns of forest change; the first day featured formal presentations on analysis of tree rings as they are used in evaluating changes in forest condition over time (see p. 5 this issue for more on the same subject). The workshop next day was devoted to detection of the effects of

Continued on page 18

Regional Highlights, *Continued*

Research at U/AZ has found that *Sequoiadendron giganteum* is an excellent recorder of fire scars. We are in the process of developing an unprecedented several thousand year fire chronology for several locations within the sequoia mixed-conifer forest zone of SEKI. In conjunction with an in-house study of sequoia age structure in the same locales we expect to unravel an exciting story of the role of disturbance (both fire and climate) in determining forest structure. This work has been funded by WASO NRPP and WR Natural Science funds in response to numerous questions that have been recently raised regarding the proper role of fire in sequoia forests. I will report further on this exciting work in the near future."

Gary M. Fellers and Charles A. Drost presented a paper entitled "Distribution, density and population status of island night lizards on Santa Barbara Island, California" at a symposium on Management of Amphibians, Reptiles, and Small Mammals in North America. Their research has shown that this Federally-list lizard is notably abundant in its preferred habitat at Channel Islands National Park and the lizards are in no danger of becoming extinct. An 82-page report documents these findings.

Point Reyes National Seashore is in the second year of a Peregrine hacking program. Three fledglings were released in both 1987 and 1988 at a hack site in a remote area of the park. The project is jointly sponsored by the National Seashore, Peregrine Fund and the Santa Cruz Predatory Bird Group.

Alaska Region

Alaska Region helped sponsor the Aug. 12-14 meeting in Fairbanks of the International Wolf Symposium/International Union for the Conservation of Nature and Natural Resources (IUCN) Wolf Specialist Group Meeting. The 3-day symposium included a 1-day session on the status of wolves in countries represented on the IUCN Wolf Specialist Group; members in attendance represented Italy, Israel, Finland, Norway, Sweden, Spain, Portugal, Mexico, and the U.S. A paper on "Wolf Management in Alaska's NPs and Preserves" was given by Layne G. Adams, ARO Wildlife Research Biologist; Thomas J. Meier and John W. Burch (Denali wolf project staff) and L. David Mech (USFWS-Denali wolf project principal investigator) gave a paper on "Demography and Food Habits of Wolves in Denali NP&P, Alaska."

Dale Taylor, ARO Wildlife Research Biologist, and David Manski, Aniakchak Resource Management Specialist, took part in a joint NPS/USFWS/AK Dept. of Fish and Game study of brown bears in Aniakchak NM&P and Peninsula Wildlife Refuge. A bear census method is being developed for use in Aniakchak and Katmai NP&Ps; 59 brown bears were captured in four days. Is this a record?

Two new ARO Natural Science Final Reports available through Regional Chief Scientist Al Lovaas are: "Effects of All-Terrain Vehicle Use in the Vicinity of Anaktuvuk Pass, Gates of the Arctic NP, Alaska: I. Study of Established, Recovery, and New Trail Segments," by Gary M. Ahlstrand, Susan E. Cantor, and Charles H. Racine, and "Age Determination of Brooks Camp Cabin

Ruins, Katmai NP, Alaska" by Gary M. Ahlstrand.

Layne Adams, Jenny Zimmerman, Grad Shults, and Bruce Dale (all members of the AR Natural Resources staff), with assistance from Denali NP&P staff, successfully carried out the Denali caribou calf mortality study. Of 36 calves radio-collared, about a third were killed by bear and wolf predation. A male and female grizzly also were radio-collared. The female took several caribou calves, but the male was more interested in the breeding season. A pack of five wolves moved in on a group of 14 caribou cows and 14 calves and took all of the calves.

Gary Vequist has accepted a Resource Management Specialist position in the regional office. He had been the RMS at Glacier Bay NP&P since 1981. He also has held assignments at Yellowstone, Everglades, and Great Smoky Mountains NPs and Death Valley NM.

Julie Michaelson has joined the AR Natural Resources staff as a biologist associated with GIS efforts. Julie formerly was with the BLM district office in Anchorage, where she was involved in vegetation, remote sensing, and GIS related projects.

An initiative is being prepared to provide and allocate staffing for a greatly increased program of natural and cultural resources research, inventory, monitoring, and management and for subsistence management. Details will be provided in the Winter issue of *Park Science*, according to Dale Taylor, NPS Wildlife Research Biologist for the Alaska Region.

cumulative exogenous disturbances on tree ring series.

At Gatlinburg, the first day formal presentations were on bioindication and protected area monitoring; the second day workshop was on global climate. "Mechanisms and Alternative Hypotheses" was the title of opening day presentations at Raleigh, with the workshop next day examining "Linkages - Seedlings, Stands, and Ecosystems."

For more information, contact Bev Law or Jeff Brandt, EPA Lab, 200 S.W. 35th, Corvallis, OR 97333; (503) 757-4772 or 4311.

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Diversity, a news journal for the plant genetic resources community (published by Genetic Resources Communications Systems, Inc., 727 8th St., S.E., Washington, D.C. 20003), has published a 20-page summary of the May 9-11, 1988 Beltville Symposium XIII, on Biotic Diversity and Germplasm Preservation - Global Imperatives, held at the Beltsville Agricultural Research Center in Beltsville, Md. While most of the coverage dealt with germplasm utilization, collection, and data management, attention also was given to threatened habitats. Rodrigo Gamez from the Center for Investigation of Cellular and Molecular Biology at the University of Costa Rica, described Central America's and Mexico's focal position in world history as a center of biotic diversity and the current disruption of ecosystems there as a result of rapidly growing population, complex political and socioeconomic pressures, and ignorance of sustainable agriculture and forestry practices. Disappearance of irreplaceable germplasm may well occur, he predicted, depending on how successful is the conservation of the wide range of habitats and cultural traditions typical of the area. "This task," he said, "will be attainable only if perceived as a shared responsibility of Central American, Mexican, and industrialized nations."

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A female peregrine falcon named Red-Red, born at Cornell University's peregrine breeding facility in Ithaca, NY, and released two years ago at Acadia NP in Maine, made page 420 in Vol. 241 of *Science* when she gave birth recently at the NY Hospital-Cornell Medical Center - the result of a whirlwind romance with a city slicker who "literally swept her off her feet" in the Naked City.

The raptor romance was reported because of its part in the resurgence of the endangered peregrine in the eastern United States, where 67 known nesting pairs now compare favorably to the situation 8 years ago, when no such nesting pairs were known there.

Red-Red chose to nest in the Cornell-affiliated Medical Center in Queens on a ledge between the 24th and 25th floors on the building's east side, using the nearby open spaces and water as hunting area for providing her two babies with all the pigeons, starlings and sparrows they need.

**

News of two new publications comes from the California Native Plant Society. *Conservation and Manage-*

gis notes

Software

The Tektronix version of GRASS (for the Opus Systems processor and the Tektronix 4325 UNIX workstation) is currently under construction. We expect completion this summer.

Translators for moving data to and from SAGIS and AutoCAD are in place. The SAGIS-to-AutoCAD translator creates AutoCAD .dxf files for polygons, lines, or points. The AutoCAD-to-SAGIS translator creates SAGIS mapfiles for AutoCAD polyline, line, or point data.

A set of DOS programs exist for creating SAGIS mapfiles from dBASE data. These programs automatically create a properly formatted text file from appropriate dBASE fields for input to SAGIS. Once read in to SAGIS, the data may be repeatedly used with dBASE for analyses and plots.

Hardware

I have prepared a sample set of requisitions for acquiring GIS hardware, including items from the DOI GIS peripherals contracts (**Park Science**, Winter and Spring '88). The requisitions are intended as an aid in acquiring GIS hardware and are to be used in conjunction with your NPS-62 (ADP justification).

Staffing

I have prepared a generic position description for a GIS specialist. It may be useful as a source of ideas for your own park GIS specialist position.

CADD vs. GIS

I am frequently asked about the differences between CADD systems and GIS's. To many people they both seem to do the same thing (automated mapping), and CADD software and hardware may seem more accessible and easier to get started with. In fact, if all you want to do is automated mapping, then CADD is very likely the way to go. If, however, you are interested in analytical capabilities, such as buffering, proximity analyses, counting, length determinations, intersection analyses, modeling, use of satellite data, and so forth, then GIS is probably the direction to take.

Capabilities aside, the fundamental difference between CADD and GIS lies in the nature and, particularly, the **structure** of the data. Because they are **design-oriented**, CADD systems work with drawings. Linework and text occur on drawing **layers** and have certain intrinsic and associated display characteristics, such as line type (dashed, solid, double, etc.), color, symbology (gates, rocks, fire, etc.), or fonts. You access the drawing elements by calling up and combining the layers as you wish to compose a unique

drawing specifically tailored to your particular requirements. The data themselves are typically referenced to a relative coordinate system based upon a digitizing table or the drawing itself. A wide variety of powerful display operations, such as zooming, scaling, rotating, shading, and even 3-D, are possible.

In contrast, GIS's work with discrete spatial objects, such as points, lines, polygons, or cells. Each object is either individually accessible or accessible as a group, such as a group of polygons or cells constituting a given vegetation type, soils class, or ownership category. The concept of a "drawing layer" does not exist, although like objects, such as all vegetation types, may, merely for convenience of access, be grouped into one thematic file, such as vegetation. The data are typically referenced to a real-world coordinate system, such as UTM or long/lat.

Each spatial object relates in a precise way to every other spatial object: polygons share common arcs with neighboring polygons and have clockwise-ordered vertices, holes (exclusion areas within polygons) may be contained within polygons and have counter-clockwise-ordered vertices, nodes snap, and each object has an associated "tag," or feature name, which allows it to be accessed and manipulated individually. Text and display characteristics, such as line color, shading patterns, symbology, and the like, are not stored; typically, these are generated on the fly, i.e., whenever output is required, although text may also be stored for repetitive recall and use, if desired. The ability of GIS's to work with raster (i.e., cell-type) data is also an important difference between CADD and GIS systems; I do not know of any CADD system that can handle raster data.

GIS's are particularly well-suited to analyzing and combining different kinds of spatial data, although they normally are no slouches at displaying the data, either. They may not have all the symbology, line styles, and text fonts of CADD systems, but they can usually produce a pretty decent-looking plot. A GIS is very likely the system of choice where analysis and modeling of spatial data is the predominant requirement.

Whichever software system is more suited to your needs - and you can use both, if you like - one essential requirement prevails: the ability to move the spatial data back and forth between the two systems. It is vital that the data be as universally useful as possible, so that time, expense, and energy are not wasted constructing a single-purpose data base.

Harvey Fleet, Chief
Digital Cartography, DSC

ment of Rare and Endangered Plants, edited by Thomas Elias, director of Rancho Santa Ana Botanic Garden, is somewhat of a minor publishing miracle. It became available for distribution less than one year after the conference at which its collection of papers were delivered. Its 640 pages include abstracts, bibliographies, index and illustrations and record the proceedings of the largest conference ever held in North America to address rare and endangered plants. ISBN 0-943460-11-5 (clothbound) is \$45; ISBN 0-943460-12-3 (softbound) is \$24.95.

A new, expanded edition (1988) of *Terrestrial Vegetation of California*, edited by Michael G. Barbour and Jack

Major of UCal/Davis has already sold out its first printing, and a second printing became available in August 1988 for \$57.50 plus tax and shipping (ISBN 0-943460). This 1,036 pp. illustrated volume is the standard reference work and includes the famous, large-format A.W. Kuchler *Vegetation Map of California*, full color, showing distribution of 54 vegetation zones.

Both books may be ordered from the CNPS at 909 12th St., Suite 116, Sacramento, CA 95814, (916) 447-2677.

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Continued on page 19

"Climate changes over the last few centuries have been accompanied by changes in the fire regime," according to James S. Clark, now at the New York State Museum in Albany. His research, reported in the July 21, 1988 issue of *Nature*, aimed at establishing the general relationship between fire and climate, was conducted at Itasca State Park in Minnesota. There, he measured the amount of charcoal in lake bottom sediments, where annual sediment layers made it possible to trace fires to individual years and to identify cycles in fire history.

Clark found the forest in the study area burned roughly once every nine years during the relatively warm, dry 15th and 16th centuries. The next three centuries constituted what is known as "The Little Ice Age," and blazes then occurred less intensely about every 14 years.

R. Monastersky, commenting on the Clark research in the July 23, 1988 *Science News*, cites the "greenhouse" warming trend that may currently be starting and suggests that in the light of what seems to be happening in that regard, "fires will presumably become more frequent in the future."

Clark warned that continued fire suppression, coupled with further climate warming, could result in fuel buildup that would give more intense and probably more frequent fires. He mentions the NPS policy of controlled burns as a counteractive measure to this threat.

Report on Human Skeletal Remains

A report on the skeletal remains of approximately nine Native Americans, found at the site of Fort Vancouver National Historical site in the state of Washington, describes the gender, age, and pathology of the individuals, whose demise probably dates back 200 years.

M. Ann Bennett, professor of anthropology at Portland State University, prepared the 69-page report. It provides a permanent record of descriptive data on the remains and can be used as a basis for eventual return of the remains to the appropriate Native American authority for reburial. The bones were uncovered six years ago when a new highway was being constructed adjacent to the Fort Vancouver site. Evidence seems to indicate a Chinook tribal connection, according to Kent Bush, Regional Curator for the Pacific Northwest Region of the National Park Service.

A limited number of the reports are available from Bush at PNRO, 83 S. King Street, Suite 212, Seattle, WA 98104.

Global Climate Change, DOI, and the NPS

Global warming and related climate changes due to the "greenhouse effect" are expected to have a major impact on the earth's life within the next century. This has prompted Congress to introduce legislation to study and ameliorate the situation and the Department of the Interior (DOI) to begin studying possible effects on its bureaus and the policy options. The National Park Service, which stands to be affected as greatly as any DOI agency, is beginning to engage the subject through the Departmental Working Group on Climate Change and through conferences.

Scientists studying the effects of greenhouse gases, including carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and several chlorofluorocarbons (CFCs), have tried to predict how quickly and to what extent atmospheric temperatures may rise. In 1979, the National Academy of Sciences concluded that a doubling of CO₂ would lead to an increase of 1.5 to 4.5°C (3 to 8°F) in average annual global air temperatures. Since then, other researchers have concluded that an increase of all greenhouse gases equivalent to CO₂ doubling is likely to occur as early as the 2030s, with commensurate global warming lagging by several decades. Under such a scenario, temperatures would rise higher than the planet has experienced in the past 100,000 years, at a rate many times faster than occurred in the past. This would put unprecedented pressure on many species to migrate or be wiped out.

Though scientific consensus seems to have been reached on global warming, there is much more uncertainty about regional changes in temperature and associated changes in precipitation. The prevailing view is that warming will be relatively greater toward polar regions. Global climate models indicate that, on the average, precipitation should increase, though they disagree on magnitudes and regional variation.

In response to the Global Climate Protection Act of 1987, the EPA is preparing a report to Congress on the impacts of global warming in the United States. The report will analyze some issues on a nationwide basis, but the focus will be on regional effects, with case studies in California, the Great Lakes, the Southeast, and the southern Great Plains. The Southeast studies will include potential effects of water quantity changes and sea level rise on Lake Okeechobee and the Everglades ecosystem. EPA cautions that the present reliability of regional climate models allows only qualitative statements about regional effects, under a range of climate scenarios. The report is expected to be completed early in 1989.

The Department of the Interior has established a Working Group on Climate Change to coordinate Interior's involvement in climate change research and policy. This will include reviewing EPA's report to Congress as it relates to DOI responsibilities and bureaus. Bill Gregg, MAB Coordinator, is the NPS representative in the Working Group, which is chaired by Martin Smith, Deputy Assistant Secretary/Director, Office of Policy Analysis. Possible effects of global warming on DOI bureaus are being discussed and studied to establish a basis for policy formulation.

Several aspects of the issue that will affect the Park Service have been identified. One is sea level rise. Global warming may cause thermal expansion of the oceans and melting of the polar ice caps. The resulting rise in sea level would cause soil saturation, inunda-

tion, and increased erosion at shoreline areas such as Cape Hatteras NS and Channel Islands NP. Habitats would be affected and structures could be destroyed.

Changes in temperature, precipitation, and water availability would affect environments in all NPS areas. These changes could be intolerable to some species, forcing them to migrate if surrounding environments were favorable. Otherwise, they could become locally extirpated. Such changes also could affect the preservation of historic structures and landscapes.

Global warming could cause a change in the aesthetics of national parks; e.g., less or more snow on the mountains; changes in river flow; changes in the appearance of forests and other vegetation because of different species composition.

Recreation on natural lakes or reservoirs in park areas might be affected by changes in water level and seasonal variation.

Climate change might lead to significant changes in visitation patterns and recreational use of parks.

A number of policy questions have been posed. In view of potential widespread habitat changes due to human effects on the atmosphere, how should the NPS policy of minimal intervention be applied? Should the NPS try to assist in ecosystem or species migration where land use patterns make migration difficult? Should the NPS modify its general management plans and philosophies to deal with climate change? Should land purchases be made on or near the seashore? Should more or less investment be made in erosion control? Could the NPS contribute to a policy of afforestation/reforestation to increase removal of CO₂ from the atmosphere, and if so, how?

While the Department and NPS wrestle with such questions, Congress is considering further legislation. Senator Wirth of Colorado has introduced a wide-ranging bill that calls for studies by many government entities, including DOI, to find ways to deal with and adapt to climate change, among them alternative energy use and protection of tropical forests. A bill by Senator Stafford of Vermont focuses on reduction of CO₂ emissions. And legislation introduced by Senator Hollings of South Carolina would amend the National Science and Technology Policy, Organization, and Priorities Act of 1976 to, among other things, develop a national plan to improve scientific understanding of the earth system and the effect of changes on climate and human well-being.

Global warming is suddenly a hot topic for conferences as well. The NPS is involved in at least two this fall. One is on Consequences of the Greenhouse Effect for Biological Diversity, convened by the World Wildlife Fund-U.S. in Washington, D.C. October 4-6. The seven sponsors include NPS. And at the George Wright Society-NPS research conference in November at Tucson, a minisymposium will address global change. Paul Risser and Francis Bretherton of the National Academy of Sciences Global Change Committee will describe the status of this issue, and two NPS speakers will comment on potential impacts of global warming on parks.

There is little doubt now that discussion and action on global climate change will be high on the Park Service, national, and international agendas for a long time to come.

Napier Shelton
NPS Washington Office

Is RT and E Species Management Itself a 'Threatened' Candidate?

By Jeff Marion and John Karish

The Endangered Species Act of 1973 directs all Federal agencies to "seek to conserve endangered species and threatened species . . ." In accordance, NPS "Management Policies" states that "The Service will identify all threatened and endangered species within park boundaries and their critical habitat requirements . . . Plant and animal species considered to be rare or unique to a park shall be identified also and their distribution within the park mapped. Management actions for their protection and perpetuation shall be incorporated into the natural resources management plan." The latest revision of these policies further defines threatened and endangered species to include not only federally listed species, but also federal candidate species and state and locally listed threatened, endangered, rare, declining, sensitive, or candidate species that are native to and present in the parks.

These policy directives raise the question "Are we doing our job?" Clearly, we must begin with comprehensive surveys of all the rare, threatened and endangered (R, T&E) species within park boundaries. A recent survey of park managers, conducted by Frances Kennedy for the National Parks and Conservation Association (NPCA), suggests that many parks have not completed R, T&E surveys and therefore lack information essential to the management of these species and their critical habitats. In Volume 7 of the recent NPCA plan for the NP System (*Investing in Park Futures: A Blueprint for Tomorrow*), it is recommended that an additional \$10 million in appropriations be sought to research and compile a standardized, Service-wide inventory of all listed species.

In this paper we share what we consider to be an effective approach to inventorying R, T&E species and managing R, T&E information. Such surveys require specialized expertise often lacking in many parks and regions. In the Mid-Atlantic Region these surveys have been accomplished through cooperative agreements with the State Natural Heritage Programs (SNHPs). The organization, goals, and capabilities of The Nature Conservancy/State Natural Heritage Programs are covered in the accompanying article by Robert Chipley.

Managing Rare, Threatened and Endangered Species Data

Comprehensive and up-to-date R, T&E information is essential to park managers if they are to provide the protection these species require. The information must be accessible at the park level for consideration in park planning and operational activities. Several information management approaches available to parks are described below.

The Threatened, Endangered, and Exotic (TEX) species module in NPS COMMON now contains general information on most federally listed threatened and endangered species occurring in NPS units and is accessible to all parks by computer modem. However, this database does not include federal candidate or state listed species, or detailed species- and park-specific information, such as the locations, size, and status of populations.

As described in the **Park Science** Computer Corner, Summer 1987, a dBASE III database modeled after the TEX module was to be developed so that individual parks could manage R, T&E data on microcomputers, allowing parks the ability to input additional information as necessary. It is uncertain at this time when or if such a database will be developed. Parks may choose to develop their own R, T&E databases.

The U.S. Fish and Wildlife Service has compiled a body of information on all federally listed species in

a database known as ESIS (refer to **Park Science** Computer Corner, Summer 1987).

Information requests to USFWS must identify the counties in which the park is located.

The Natural Heritage Program databases described in the accompanying article are the oldest, most comprehensive (includes all federal and state R, T&E species), and most complete (in terms of parameters) of any in existence. The databases include detailed location and habitat information, as well as the characteristics, numbers, condition, and status of each element occurrence. As field surveys and herbaria/museum searches are conducted, species occurrences are routinely mapped and input to the database . . . a valuable source of information for parks.

By contacting the appropriate State Natural Heritage Program, a park can establish a protocol for obtaining the latest available information on R, T&E species occurrences within park boundaries. The first request for available information from a SNHP should be accompanied by a map showing current park boundaries and major inholdings. SNHP's first record rare species locations on USGS 7½' topo maps and then enter various parameters, including land ownership, from the map into the database. Thus it is essential that the SNHP has park boundaries accurately delineated on their maps; otherwise species occurrences on park lands may not be recorded as such in the database. Mapped and computer database information on park R, T&E species, such as rankings and population data, can then be requested. This information will be most complete if the R, T&E field survey and record search has been conducted for the park by the SNHP.

Parks with large numbers of R, T&E species, or groups of parks, may wish to consider an even closer involvement with The Nature Conservancy (TNC). The NPS Southeast Regional Office recently entered into a Cooperative Agreement with TNC to open a SNHP data center at Great Smoky Mountains NP. Data from the Tennessee, North Carolina, and Tennessee Valley Authority SNHPs has been downloaded into the park's data center for ready access by park resource managers and scientists. A second SNHP is being planned to serve several of the South Florida park units. Park resource managers may consider cooperative monitoring efforts with SNHP personnel. SNHP staff have standardized procedures and forms for monitoring and can serve as a resource in cooperative efforts or in training NPS staff for monitoring. SNHP staff also are available for review and consultation in park planning and construction work.

Rare, Threatened and Endangered Species Surveys

The first R, T&E surveys in the Mid-Atlantic Region began in 1985 with the SNHPs of Pennsylvania, New Jersey and New York for Delaware Water Gap NRA and the Upper Delaware Scenic and Recreational River. Surveys start with a Request For Proposal (RFP) describing the survey objectives, work to be accomplished, and products. The cooperator responds with a proposal addressing the RFP and outlining a budget. In the Mid-Atlantic Region, depending on available funding, surveys have been conducted on both an individual park and statewide basis. We have found that both the contracting and survey work (searching the literature and herbaria records, for example) are more efficiently carried out when all parks in a state are done concurrently.

The objectives included in our most recent RFP are to: (1) identify records, occurrences, and status of plant and animal species and vegetative communities listed by state and federal agencies as rare, threatened, or endangered within, adjacent to, or potentially occurring in the specified park(s); (2) field survey and verify locations of recorded occurrences; (3) field survey potential habitat locations for new occurrences of rare species or communities likely to be present; and (4) record and map all historical and extant rare species and community locations according to standard SNHP methods and procedures.

Survey work begins with the SNHP obtaining maps showing current park boundaries and all major inholdings. Cooperators identify and search all appropriate herbaria, museums, collections, and scientific literature for records of R, T&E occurrences within or adjacent to the park. Field surveys are conducted to inventory and verify recorded occurrences and to gather information on site locations, population numbers and condition, habitat and site requirements, degree of endangerment, known or suspected threats, management recommendations and other items on standard Heritage Program forms, maps and databases.

A report is prepared describing the project's study methods, accomplishments, findings and recommendations. Information from the record and field searches is then summarized for each historically recorded and extant species and community in the park and for those elements adjacent to the park that may potentially occur in the park. This includes the species' or community's locations and distribution, habitat requirements and restrictions, federal and state listing or rarity status, and rarity within the park; the significance of the park's population in relation to its state (and, if possible, national) distribution or range; the degree of endangerment and known or suspected threats; and recommendations for monitoring, protection and management actions and procedures.

The park(s) also are provided with maps locating all critical areas in and adjacent to the park, SNHP field survey forms, element abstracts and state and global ranking forms, and summaries of Heritage element occurrence records.

Finally, Heritage personnel are asked to accompany a park Resource Management staff member to each existing and important historical field location to identify visually the location and species or community of interest. Photographs of rare species located during the field surveys also are required to aid in future identification and for use by Park Interpretive programs.

Marion is a Regional Research Biologist; Karish is North Atlantic Regional Chief Scientist.

State Natural Heritage Program: TNC's Partnership Approach

By Robert M. Chipley

Incorporated in 1951, The Nature Conservancy (TNC) is a nonprofit organization committed to the preservation of natural diversity. Operating through identification, protection and stewardship of biologically critical sites, TNC now has over 400,000 members and manages the largest private preserve (numbering some 1,000) system in the world. Many of these reserves are critical reservoirs for populations of rare, endangered and threatened species and natural community types.

To meet our ambitious goal, we must spend scarce time and resources on the biologically most critical areas. Key to TNC's ability to identify such areas have been the State Natural Heritage Program (SNHPs), on which we rely in determining our protection agenda. First begun in South Carolina in 1974, these programs strive to create within the state a permanent and dynamic atlas and database on the existence, characteristics, numbers, condition, status, location, and distribution of occurrences of the elements of natural ecological diversity. The programs now operate in 48 states, 9 Latin American countries and one Canadian province.

Each program is set up as a partnership, involving a two-year contract between TNC and a natural resources agency in the state, such as the Maryland Department of Natural Resources, the New York Department of Environmental Protection, the Nebraska Game and Parks Commission and the California Department of Fish and Game. Under the agreement, TNC agrees to hire and train a staff (generally a coordinator, a botanist, a zoologist, a community ecologist and a data manager) in program methodology and to advise and supervise them as they set up the database. The state generally agrees to provide office space and support and declares its intention to incorporate the completed program into state government. Funding comes from the state, from federal funds and from private fundraising by the Conservancy. At present, 32 programs have fully transferred to state government; some of these have been part of state government for over 10 years.

The Heritage process begins with putting together a list of items (known as "elements") to be inventoried. These include rare, threatened and endangered (R, T&E) plants and animals and important natural community types. Our sources are existing lists, such as the plant lists put together in Maryland under contract with the USFWS. We then circulate these lists to appropriate experts in the state. Generally the lists incorporate up to 15-20 percent of the vascular plants and a like percentage of vertebrate animals. Included also are selected nonvascular plants and invertebrate animals on which there is sufficient information to determine their status. We also develop community classifications to include all important old-growth communities plus selected successional communities. The lists change as further information becomes available.

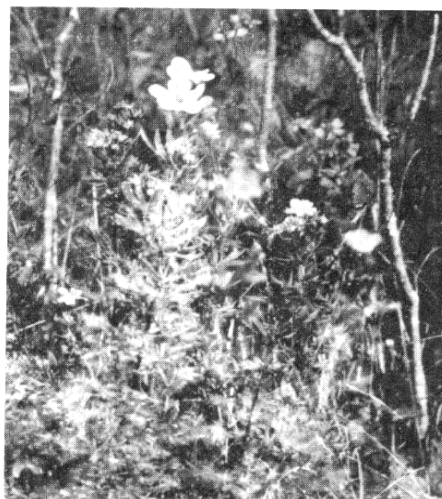
Each element is assigned two ranks to reflect its degree of rarity and endangerment – a global rank for its status throughout its range, and a state rank for its status in each state. Most vascular plants and all vertebrate animals in the U.S. already have been assigned global ranks. The TNC ranking system is easy to use and to interpret. In the global system, ranks



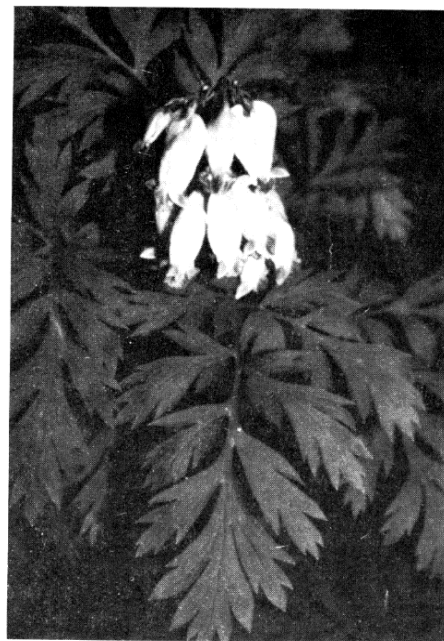
Parnassia glanca, lobelia kalmii



Potentilla fruticosa, calcareous fern



Potentilla fruticosa



Dicentra exima



Potentilla fruticosa

Photos of five R, T&E species not federally listed, taken at the Delaware Water Gap NRA by the PA State Natural Heritage Program staff during their surveys of the park.

range from G1 (critically endangered with fewer than 5 occurrences or 1,000 individuals on earth) to G5 (extremely common and widespread); the state system parallels the global system, ranging from S1 to S5, but refers only to the element's status within the state's borders. Both global and state ranks are tracked in the central databases at TNC headquarters in Arlington, VA, and are accessible to anyone.

Once elements have been listed and ranked, we do a thorough search of secondary information; sources include specimen collections and herbaria, the literature, and knowledgeable individuals. Our goal is to determine point locations in the state for occurrences of the elements on our lists. Each time we encounter an item of this type – for example, the collection point of a specimen of a rare plant deposited in herbarium at the state university – we create a computerized "Element Occurrence Record" which in-

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Heritage Program

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corporate all the information from the specimen label sheet plus everything of relevance we discover subsequently – ownership of the land, results of field surveys to the site, population size and trends, etc. For each point, we also plot and mark the location onto our base maps – an entire set of the 7.5-minute topographic quad maps of the state. Each program scientist starts at the top of the list as determined by the ranking system – information on G1S1-ranked elements is gathered first, and gradually works down until all elements are represented by occurrences. Once secondary information has been incorporated, we begin field surveys, again concentrating on the rarest and most endangered elements on our lists.

We also accumulate information on "managed areas" – those owned and managed by conservation groups such as TNC, by federal agencies such as the Park Service, the Forest Service, Fish and Wildlife, Bureau of Land Management, Department of Defense, etc. and by state agencies such as state parks and forests. The boundaries of these managed areas also are plotted onto the base maps. Managed areas can function as important refugia for occurrences of rare and endangered elements.

At the end of the first two years, with processed occurrences numbering in the thousands, a picture of diversity in the state begins to emerge. We now have enough data to figure out which elements are very rare, and which are inadequately protected on managed areas – or not represented at all. We can also determine which sites in private ownership, if protected, would do most towards preserving the state's natural diversity. It is this list of priority sites that becomes the protection agenda for each state TNC office.

The Conservancy is only one of the many users of State Natural Heritage Programs. Both state and federal agencies have recognized that site-related data on this extensive array of significant taxa just aren't available elsewhere. State highway departments have used the data to review proposed highway routes and to choose among the alternatives; utility companies have done likewise for power line corridors. Land managing agencies routinely consult the programs for input into management plans. Because we can easily determine from our databases how many occurrences exist for a given species, we have conducted many status reviews for taxa proposed as endangered or threatened and prepared a number of recovery plans.

All these programs, whether transferred or still on contract, form the State Natural Heritage Program Network. The result is easy exchange of information and steady improvement in methodology. We are about to add a new software package – the Biological and Conservation Data System, which will expand and make more efficient our data-managing capabilities, while tying more closely the protection efforts of TNC state offices to Heritage databases.

The program is a two-way street, with benefits in this case accruing both to the Park Service and to the Heritage Programs. Such programs not only give NPS a proven system for managing its own element-related data, but also link NPS with the existing and expanding support system of other Heritage programs.

Chipley is director of The Nature Conservancy's Heritage Field operations.

IPM Notes

WASO Uses Databases To Keep Parks Posted On Label Changes

By Christine Cassidy

Since 1980, the National Park Service has had a commitment to Integrated Pest Management (IPM). From the start it has been the NPS goal to use the most environmentally acceptable pesticide available when one is needed. The Washington Office is responsible for keeping the parks and the regions informed of the latest laws, regulations, and IPM techniques. This office also reviews pesticide use requests and recommends the most environmentally acceptable pesticides for a particular project.

To assist with management of this program, we developed the Pesticide Use Tracking System (PUTS) in 1983, using dBase III on an IBM personal computer. Stored in this database is pertinent information taken from the pesticide use proposals (10-21A forms) and the yearly pesticide use logs that the individual parks submit. With information from this database, we have tracked pesticide use trends in the Service by pesticide

type, active ingredient, management zone, and other topics.

Last fall, an opportunity to test the capabilities of PUTS and the NPS's COMMON database occurred. The Environmental Protection Agency proposed adding language to pesticide labels to protect threatened and endangered (T&E) species. This label change would affect NPS pest management in some parks where certain pesticides are proposed for use on range, forestry, larval mosquito breeding, or agricultural sites, called cluster groups by the EPA (See Tables 1 and 2). In such cases the parks either must contact the U.S. Fish and Wildlife Service (FWS) or the state fish and wildlife agency or it must consult range maps produced by either the FWS or state fish and wildlife service before certain chemicals can be used. If the FWS, state fish and wildlife agency, or the range maps indicate that the site where the proposed pesticide is intended to be used is in the range of a T&E species, the park must select another pesticide. As part of our responsibility to keep the regions and parks informed of label changes, we had to find a way to notify regions and parks that could be affected by these proposed label changes.

In the past, we would have had to search through the approximately 1,200 10-21As that are submitted each year and to have the parks and regions search their files. This task would have taken literally months to complete,

Table 1. An Example of Part of a Cluster Group Where Proposed Use of a Specific Pesticide in Specific States and Counties Requires Contacting the FWS or State Fish and Wildlife Agency.

Endangered Species Labeling for Mosquito Larvicides Containing One or More of the Following Active Ingredients:*

Methoprene	
Methoxychlor	Pyrethrins

Contact FWS Field Offices at the following numbers:

District of Columbia (Annapolis, MD, 301-269-5448)

Rock Creek Park

Florida (Jacksonville, Florida, 904-791-2580)

Broward, Dade, Glades, Okaloosa, Palm Beach, and Walton

Georgia (Jacksonville, Florida, 904-791-2580)

Catoosa

*United States Environmental Protection Agency, Washington, DC 20460, *PR Notice 87-4 Notice to Manufacturers, Formulators and Registrants of Pesticides*, May 1, 1987.

Table 2. An Example of Part of a Cluster Group Where Proposed Use of a Pesticide in Specific States and Counties Requires Consultation with T&E Species Range Maps.

Endangered Species Labeling for Range and Pastureland Uses Containing One or More of the Following Active Ingredients:*

Ammonium Sulfamate	MCPA, acid
Atrazine	MCPA (salts and amines)
Clompyralid	Picloram
2,4-D	Potassium Picloram
2,4-D (salts and esters)	Sodium Dicamba
2,4-DP	Tebuthiuron
Dicamba	Triethylene Picloram
Dimethylamine Dicamba	Triethylene Picloram
Hexazinone	
Minnesota	
Cottonwood, Goodhue, Jackson and Renville	
Missouri	
Christian, Dade and Greene	
Nebraska	
Cherry, Garden, and Hooker	

*United States Environmental Protection Agency, Washington, DC 20460, *PR Notice 87-5 Notice to Manufacturers, Formulators and Registrants of Pesticides*, May 1, 1987.

but with the aid of PUTS and COMMON this task took a little over two weeks to complete and required only one person.

To carry out this task, we searched the two most recent years of PUTS data, 1986 and 1987, for the pesticides listed in the four cluster groups and generated a list of NPS projects that had used pesticides listed in the individual cluster groups. The cluster groups, in addition to listing the pesticides that could affect T&E species, also list the states and counties where use of these chemicals could affect T&E species. Our next step, therefore, was to use COMMON to generate a list of all the parks by state and county. The list of projects using

affected pesticides then was compared against the park, state, and county list generated by COMMON and against the pesticide, state and county list for each cluster group. This comparison resulted in a list of parks which, during 1986 and 1987, used chemicals listed in the cluster group developed by EPA (See Table 3). Should the EPA labeling proposal be adopted, if these parks propose to use these pesticides, they would have to contact the FWS, or the state fish and wildlife agency, or consult T&E species range maps. For example, Great Smoky Mountains NP which used glyphosate in Haywood County, NC, would have to contact the USFWS before using that chemical in the future.

Results from our search of the 1986 and 1987 pesticide use data indicate that 7 regions and 19 parks might be affected by the proposed label change. Specifically, in the range cluster group 6 regions and 7 parks are affected, in the agricultural cluster group 1 region and 2 parks are affected, in the forestry cluster group 3 regions and 9 parks are affected. In the mosquito larvicide cluster group only 1 park is affected.

The EPA's endangered species labeling program was originally scheduled to become effective in February, 1988, but implementation has been delayed until after Sept. 15, 1988. EPA plans to start enforcing the label requirements during the 1989 growing season. Implementation has been delayed because, for some parts of this program, additional development and more comments from the public, other government agencies, and the states are needed. However, because we do not anticipate that these refinements will significantly alter the results shown in Table 3, we are developing NPS guidance recommendations to respond to the proposed label changes.

This project is one example of the many ways in which the Washington office can use PUTS and COMMON to keep the parks and regions informed of changes in IPM and pesticide use practices. Eventually, the EPA plans to have a total of 12 cluster groups in the T&E species labeling program, and we expect to be able to use COMMON and PUTS to inform the potentially affected parks and regions of the additional pesticide use constraints as each new cluster group is introduced by the EPA.

Cassidy was a Biological Technician in the Wildlife and Vegetation Division, NPS, WASO; she is now a Pesticide Inspector for the District of Columbia.

Table 3. Pesticide Use Projects Which May Be Affected By The EPA Endangered Species Pesticide Labeling Program (12/14/87)

EPA Cluster Group – Range					
Region	Park	Active Ingredients	State	Counties Affected	Park Project Numbers
MW	Wilson's Creek NB	2,4-D	MO	Christian, Greene	87-011/87-015
MW	Wilson's Creek NB	Ammonium Sulfamate	MO	Christian, Greene	86-003
PN	Nez Perce NHP	2,4-D	ID	Idaho	87-001
PN	Nez Perce NHP	MCPA	ID	Idaho	87-004
RM	Curecanti NRA	2,4-D	CO	Montrose	86-002
RM	Pipe Spring NM	Ammonium Sulfamate	AZ	Mohave	86-002/87-002
SE	Stones River NB	Ammonium Sulfamate	TN	Rutherford	86-004
SW	White Sands NM	Picloram/2,4-D	NM	Dona Ana, Otero	86-001
WE	Hawaii Volcanoes NP	Picloram/2,4-D	HI	Hawaii	86-024/86-033 86-035/86-038
EPA Cluster Group – Agricultural					
SE	Natchez Trace PKWY	Atrazine	AL	Colbert, Lauderdale	87-011/87-024
			MS	Clairborne, Hinds, Itawamba	
			TN	Hickman, Lawrence, Maury, Wayne	
		Methomyl	AL	Colbert, Lauderdale	87-018
			MS	Itawamba	
			TN	Hickman, Maury, Wayne	
		Parathion	AL	Colbert, Lauderdale	87-016/87-017
			MS	Itawamba	
			TN	Hickman, Maury, Wayne	
		Trifluralin	AL	Lauderdale	87-014
			MS	Itawamba	
			TN	Hickman, Maury, Wayne	
SE	Shiloh NMP	Carbaryl	TN	Hardin	86-013/86-014 86-018
		Fenvalerate	TN	Hardin	87-012
		Malathion	TN	Hardin	86-011
EPA Cluster Group – Forestry					
MA	Colonial NHP	Glyphosate	VA	James City	87-013
MA	Fredericksburg and Spotsylvania NMP	Ammonium Sulfamate	VA	Caroline	87-001
RM	Canyonlands NP	Glyphosate	UT	Wayne	87-004
RM	Rocky Mountain NP	Carbaryl	CO	Boulder	86-001/87-004
SE	Andersonville NHS	Glyphosate	GA	Sumpter	86-004/87-004
SE	Blue Ridge PKWY	Glyphosate	NC	Avery, Burke, Mitchell, Haywood, Henderson	86-002/86-004
SE	Chickamauga and Chattanooga NMP	Glyphosate	GA	Walker	87-001/87-003
SE	Great Smoky Mountains NP	Ammonium Sulfamate	NC	Haywood	87-001
SE	Great Smoky Mountains NP	Glyphosate	NC	Haywood	86-006/86-011 87-018/87-022
SE	Russell Cave NM	Glyphosate	AL	Jackson	86-001/87-001
EPA Cluster Group – Mosquito Larvae					
SE	Everglades NP	Methoprene	FL	Dade	86-008

In the Next Issue:

Several articles that may be of immediate interest to certain parts of the National Park System for reasons of space had to be held over for the Winter issue of *Park Science*. In the interest of timeliness and with the thought that some of our readers may want to contact the authors before the January 1989 appearance of the Winter issue, here are the authors and their subjects:

Nancy Hoefs, a biologist with Colorado State University and a cooperator with the NPS Water Resources Division at Fort Collins, Colo., describes an index of biotic integrity that is proving useful as an ecological evaluation tool for aquatic resource inventories; A.C. Medeiros, Lloyd Loope, and H.F. James discuss the ancient bird bones discovered in two caves of the Kipahulu Valley in Haleakala NP, plus "exciting finds" of living cave-adapted organisms that include what may be a sole species of carabid beetle; Leslie Dubuc and Ray Owen, Jr., both of the University of Marine Wildlife Department, William Krohn of the USFWS, and Carroll Schell, Resource Management Chief at Acadia NP, document an unusual relationship at Acadia among otters, fire, and the ocean; Bob Stottlemeyer and K. McLoone look at Denali NP and Preserve for geomorphology and vegetation as determinants of surface water chemistry; and Jeff Marion reviews *Soft Paths: how to enjoy the wilderness without harming it*, by Bruce Hampton and David Cole.

**WILLIAM PENN MOTT, JR., Director
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